POWER PLANT ENGINEERING

Trade-mark reg. U. S. Pat. Office

SEMI-MONTHLY

VOL. XXII. CHICAGO, SEPTEMBER 15, 1918 No. 18

More Energy for Mansfield District

NEW MELCO PLANT OF OHIO COMPANY UTILIZES BOTH NATURAL GAS AND COAL: LOCATION INSURES CONTINUOUS AND ABUNDANT SUPPLY OF WATER AND FUEL

CONTINUOUS AND ECONOMICAL OPERATION of steam power plants depends largely upon an ensured supply of coal and water for boiler feed and condensing purposes. Locating a power house at the approximate center of gravity of its load is desirable from an economic point of view, relative to the transmission and distribution systems fed; but frequently the advantages accruing from such location may better be sacrificed in favor of a site which will place the plant within ready reach if those raw materials so essential to the production of power.

These factors must evidently have been quite prominent in the minds of the engineers of the Henry L. Doherty Co., when they decided to locate the new generating plant of the Mansfield Electric Light & Power Co. at Melco, Ohio, 13 miles southeast of Mansfield at the junction of the Black Fork and the Rocky Fork Rivers and within close proximity of the main line of the Pennsylvania Railroad. Thus an adequate supply of water is available at all times of the year and fuel deliveries may be made without interference with or by traffic in and about the Mansfield yards.

Current is transmitted over two 44,000-v. three-phase, 60-cycle circuits carried on a double pole form of construction for a distance of about one-half mile from the plant, at which point they separate, one circuit leading to Ashland, a small town located 17 miles distant, and the other circuit to Mansfield, with a short extension which supplies energy to the mills of the Mansfield Sheet & Tin Plate Co. Both Mansfield and Ashland circuits are

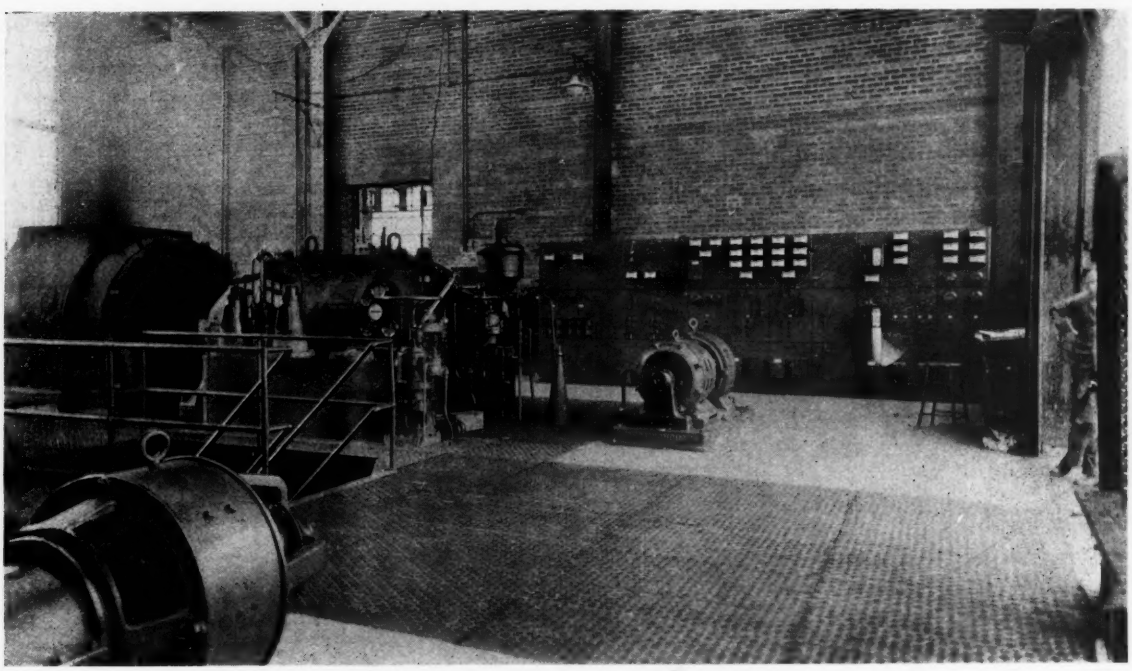


FIG. 1. GENERAL VIEW OF TURBINE ROOM

carried on 40 in. by 6 in. by 8 ft. fir cross arms supported on 40-ft. Western Red Cedar poles having 8 in. tops. The Mansfield circuit is made up of No. 0 hard-drawn copper conductors, while on the Ashland line No. 4 copper, also hard drawn, is employed.

With the arrangement employed, either or both lines may be doubled at any time in the future this may be found necessary.

The Power House

As will be noted by reference to the accompanying illustrations, the station proper consists of a fire-proof

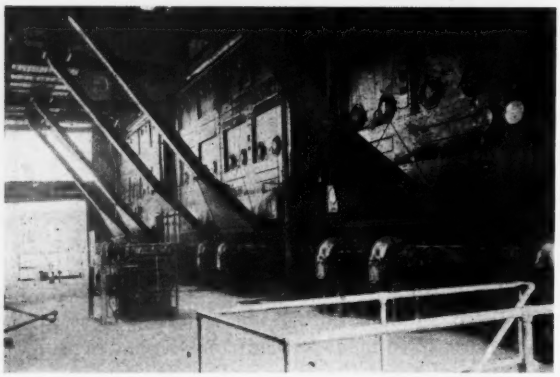


FIG. 2. STEAM GENERATING UNITS MELCO POWER HOUSE

structure of concrete and steel faced with red brick and so located and arranged as to allow extension to the building at any time such may become necessary. Concrete foundations have already been laid for an addition which when erected will be capable of accommodating equipment of such rating as will double the capacity of the installation. In anticipation of such extensions being made, the walls of both the boiler house and the turbine room are temporary, closure being by means of corrugated sheet iron sidings.

Except for the basements below where much of the auxiliary equipment has been installed, both boiler and turbine rooms are but one story in height; the switch house, however, has two floors, more conveniently to accommodate the operation of the equipment there installed.

Supply, Storage and Handling of Fuel

One of the interesting features of this plant is the arrangement by means of which either natural gas or coal may be burned under the boilers. In fact, with the scheme employed both gas and coal may be used simultaneously, should occasion so demand.

The gas is secured from a number of wells located approximately two miles from Melco and is conducted through a 4-in. line to a high-pressure regulator placed within 200 ft. of the power house, whereby the pressure is reduced from that maintained on the transmission line to about 20 lb. gage. An 8-in. line then carries the gas to a second or low-pressure regulator which further reduces the pressure to somewhat less than 1 lb., and at which it is fed to the burners, although regulating valves placed at the sides of the boilers allow the making of final adjustments according to load conditions.

A main header carried beneath the boiler room floor, through the medium of risers, distributes the gas to individual boiler headers placed as shown in Fig. 5 directly below the mud drums of the various boilers and connecting to the burners of which there are 21 for each unit. These are made up of short lengths of 1¼-in. pipe fitted with caps of like size drilled with a number of holes and are located about 3 ft. above the stoker dump-

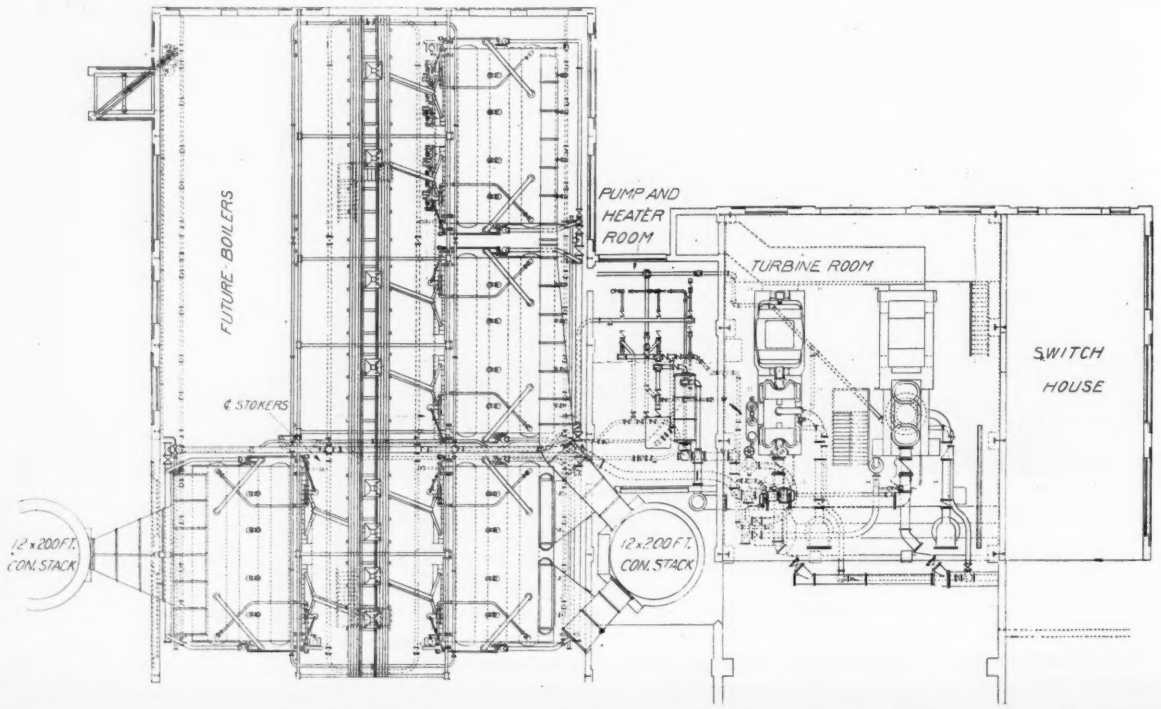


FIG. 3. PLAN OF POWER HOUSE SHOWING ARRANGEMENT OF EQUIPMENT AND HIGH PRESSURE PIPING

ing grate, the openings in the bridge wall through which they extend being lined with a tile possessing high refractory properties so as to enable the setting more readily to withstand the intense heat to which it is subjected.

Coal, as stated above, is delivered in cars over a siding of the main line of the Pennsylvania Railroad, and is either discharged into a receiving hopper, from where it is taken to the bunker above the boiler, or is dumped into a 2000-ton concrete bin arranged for submerged storage.

The method of dumping the coal preparatory to delivery to the bunkers is shown in Fig. 8. This also illustrates the inclined conveyor leading into the boiler house.

After being discharged from the track hopper, a 30-in. reciprocating feeder delivers the coal to a 30 by 30-in. single roll crusher operated by a 35-hp. electric motor, which also, through the medium of an extension on the crusher roll shaft, drives the feeder. The flywheel is fitted with break pins, so that in the event any foreign matter finds its way into the crusher these pins shear automatically, stopping the plate feeder and preventing the flooding of the belt under the crusher.

The feeder plate is suspended from skirt plates, a form of construction avoiding the use of a sub-structure and providing a ready means of access for inspection or adjustment.

Conveyor details are illustrated in Figs 9 to 12, inclusive. The exterior portion leading from the crusher house to the bunkers has an overall length of 25 ft. and is inclosed within structural steel work covered with No. 22 gage black corrugated iron, the whole being supported by the boiler room wall and two upright frames also of structural steel.

The conveyor proper consists of 736 ft. of 20-in. five-ply rubber belting having a 1/16-in. rubber covering on one side. It is driven at a speed of 258 ft. per minute by means of a 15-hp. electric motor installed at the head end and is supported and guided by 80 standard

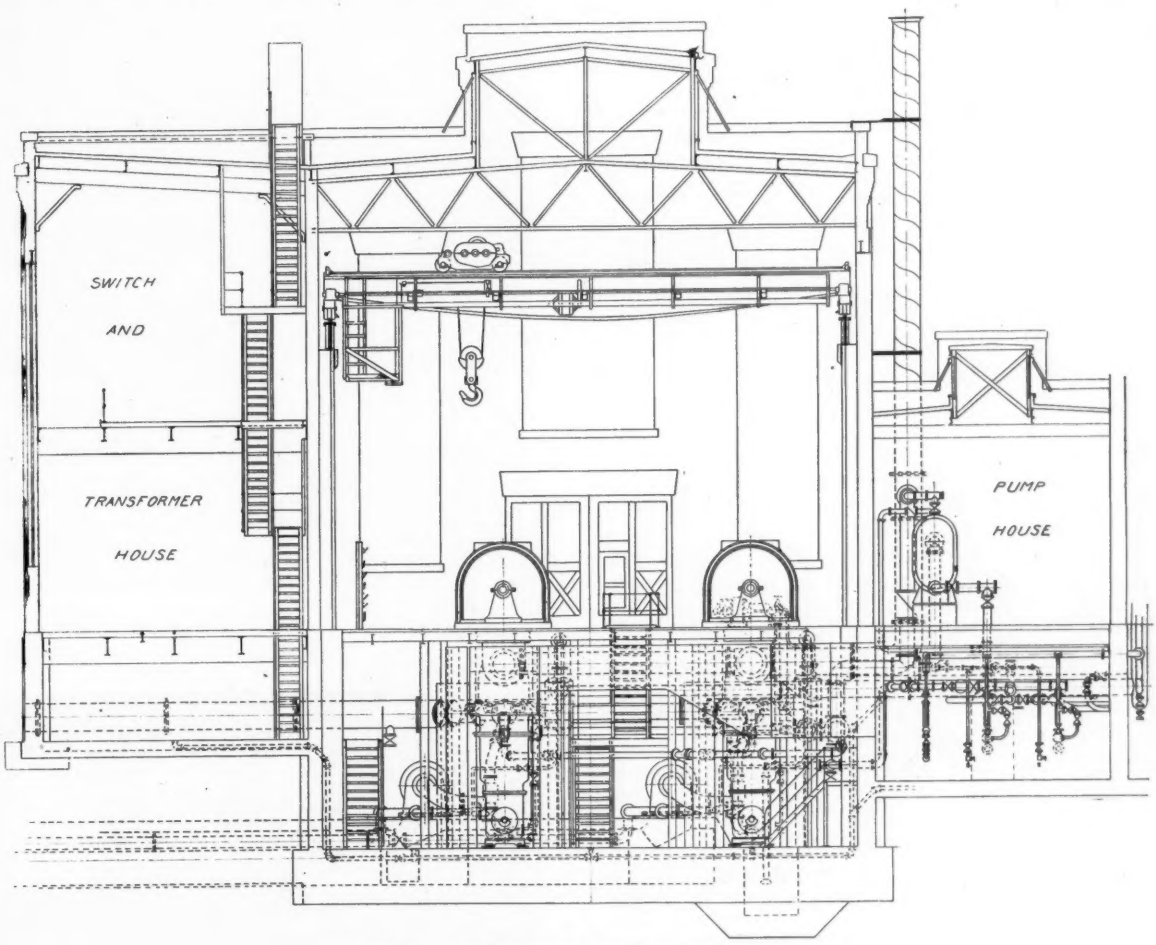


FIG. 4. SECTION THROUGH TURBINE ROOM

20 in. three-pulley troughing idlers, 36 20-in. return idlers and eight 20-in. guide idlers.

According to its rating, the equipment has a capacity of 50 tons of coal per hour, although the engineers in charge of this installation state that it is many times called upon to handle as much as 70 tons per hour.

All of the coal conveying apparatus was furnished and installed by The Jeffrey Manufacturing Co., while the bunkers which have a storage capacity of 800 tons are of Brown hoist make.

Ashes are dumped into pits below the boiler, raked into industrial cars and are at present used for filling purposes about the grounds surrounding the plant.

Boiler Feed and Blowoff Lines

Well water is used for boiler make-up. This is handled by one of two 400-gal. per minute pumps, each driven by a 15-hp. alternating current induction motor, and is discharged into a 20,000-gal. wooden tank located on a nearby hill about 85 ft. above the power house. From here it flows into a Stillwell feed-water heater equipped with a Type F2 Class 4 Bailey weir meter having a maximum capacity of 100,000 lb. per hour and equipped not only to indicate record and integrate the rate of flow of water, but also to record its temperature both upon entering and leaving the heater.

In the Bailey Weir Meter the standard V notch or rectangular weir is employed. Within the cast-iron meter tank there is provided a still pan and baffle housing two spun copper displacing members each suspended from opposite ends of a beam fastened to a Monel metal shaft, which is supported on knife edge bearings near its ends and extends through a pressure tight bearing into the recording casing. The displacing members have equal bottom areas which, however, in the case of one increases, while in the other it decreases, and are so weighted that they neither float nor act as floats.

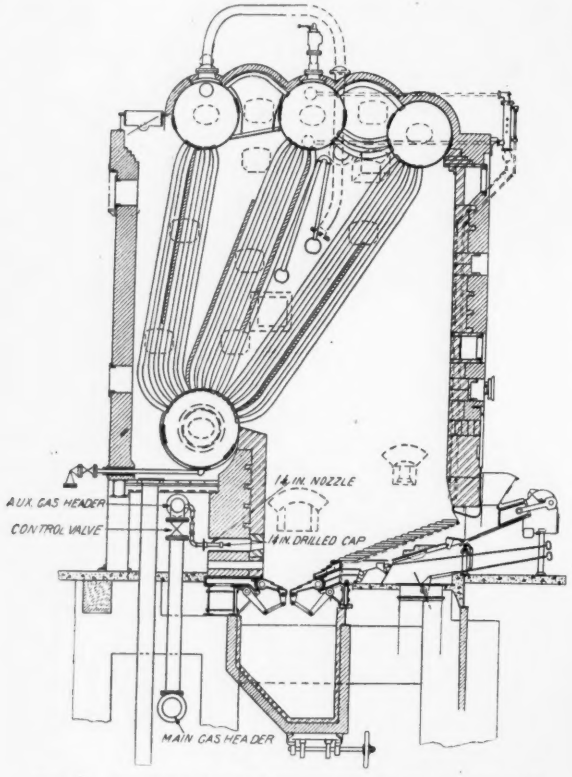


FIG. 5. SECTION OF BOILER SHOWING COAL AND GAS BURNING EQUIPMENT

As the water level rises above the bottom of the notch with increased rate of flow, the short displacing member rises partly with the water, while the long one is pushed into the water to such an extent that the buoyant force on the two is always automatically maintained equal. The resulting movement is communicated to the indicating, recording and integrating mechanism and with the shape of displacing members employed, the recording pen and integrator move in direct proportion to the rate of flow.

The water is delivered to the boiler feed distributing system by either one of two McGowan duplex steam operated pumps which, together with the heaters, are located in the pump room between the boiler and turbine rooms.

Water is delivered to the heater through a 4-in. line and removed therefrom by means of an 8-in. line which connects to the suctions of the boiler feed pumps. These in turn pump it into a 6-in. header carried along the boiler fronts but below the floor line of the boiler room. Two and one-half inch branches, one for each steam generating unit feed an auxiliary 3-in. line over the boilers and through a double connection of like size, the boilers, the scheme of connections and valving being such as to allow the use of either the main 6 in. header or the auxiliary 3-in. line as occasion or operating conditions may at any time require.

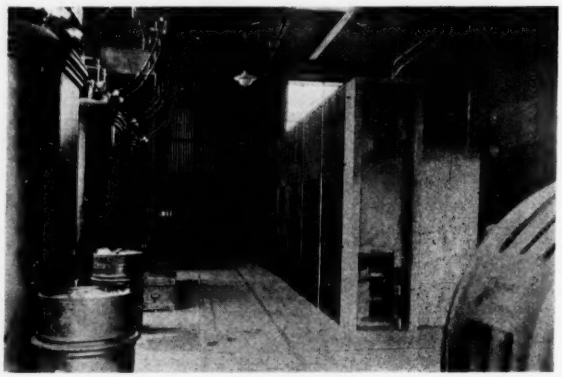


FIG. 6. TRANSFORMERS AND MAIN BUS STRUCTURE

Everlasting and Simplex valves are used on the blow-off piping. This, which consists of a run of 4-in. line with 2-in. branches for each unit, is also carried below the boiler room floor and due to the number of boilers served and its resulting length is equipped with an expansion joint to compensate for any excessive expansion or contraction of the line which may occur.

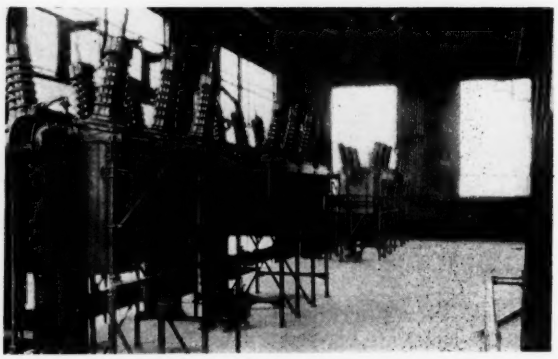


FIG. 7. HIGH-TENSION SWITCHES

Steam Generation and Distribution

Shown in the plan view of the plant, Fig. 3, is the general arrangement of the boiler room, and as will be noted the present installation consists of but eight boilers,

although room is provided for twelve. These are of the Stirling water-tube type, each rated at 512 hp. and designed to deliver steam at a pressure of approximately 210 lb. gage and superheated about 150 deg. F.

The superheaters installed on seven of the boilers also are of Stirling make; the other is a Foster unit.

Each boiler is equipped with Consolidated safety valves, independent Richardson coal scales, capable of

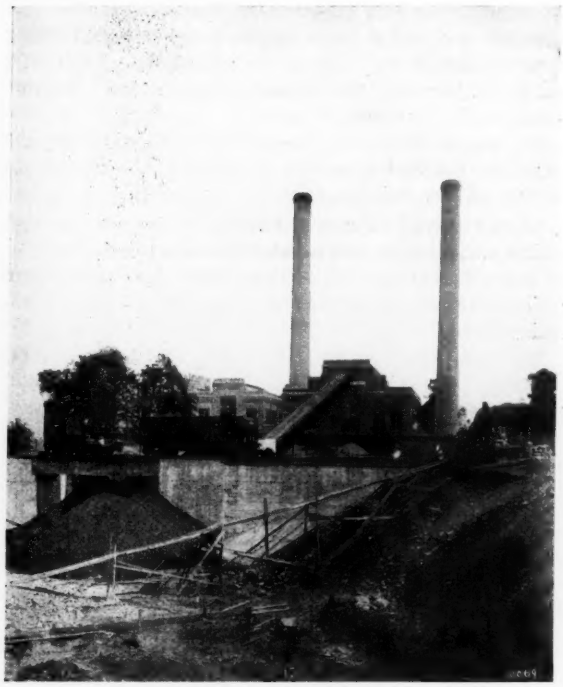


FIG. 8. COAL RECEIVING AND CONVEYING EQUIPMENT

weighing 100 lb. per tip, and Westinghouse automatic stokers. Eight of these are provided with Bailey Type D26, Class 56 Boiler Meters for the recording of the steam flow, the air flow and the flue gas temperature. The indicating of the furnace draft and the integration of the total steam flow from each boiler directly in thousands of pounds.

Columbia recording superheating thermometers are also installed.

Four Sturtevant fans, each rated at 40,000 cu. ft. of free air per minute and driven by a 65-hp. electric motor, furnish the necessary draft. These are located in the basement of the boiler room, and although the system is so designed as to provide one fan for every battery of two boilers, all discharge with a single duct, thereby insuring a continuous and ample supply of air and flexibility of operation.

Appreciating the higher degree of economy which may be secured by the forcing of boilers, the steam generating units are ordinarily operated under from 130 to 200 per cent of their rating, and at times forced even to 300 per cent. The steam leaves the boilers through 6-in. leads, connecting with two 12-in. headers carried along the rear of the settings, one of which is

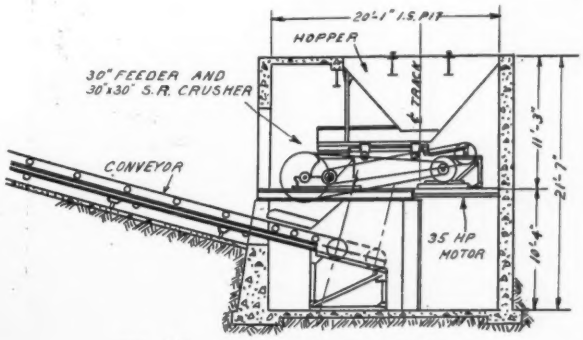


FIG. 10. COAL CONVEYOR DETAILS

provided for each run of boilers. The two headers are interconnected by means of a tie line, also 12 in.

But a single line connects the boiler room header with the turbines. As the steam leaves the boiler room header it is caused to pass through a 16-in. lead carried through the pump house and into the turbine room where, as may be seen by reference to Fig. 3, this lead is fitted with 10-in. outlets which, through the medium of globe valves of a like size, connect with the turbine supply branches. Before entering the turbine, however, all and any moisture which may be contained in the steam is removed by means of 10-in. angle type receiver separators. These, as are also all of the piping, are placed below the turbine room floor, thus adding materially to the general appearance of the turbine room, and providing an unobstructed passage for the crane in the event of installation of new machinery or the dismantling or removal of that already installed.

FIG. 9. GENERAL VIEW OF COAL CONVEYOR

The lines supplying steam to the turbines are each equipped with a Type C2, Class 24 Bailey fluid meter for recording and integrating the flow of steam. These meters, which are rated at 100,000 lb. per hour, also record on the same chart the pressures and the temperature of the steam at the throttle.

In order to distinguish the various lines and thereby facilitate operation, all high-pressure steam pipes are painted white, exhaust buff and boiler feed blue.

Electric Generating Units

As will be noted by reference to the accompanying illustrations, the main electric generating equipment con-

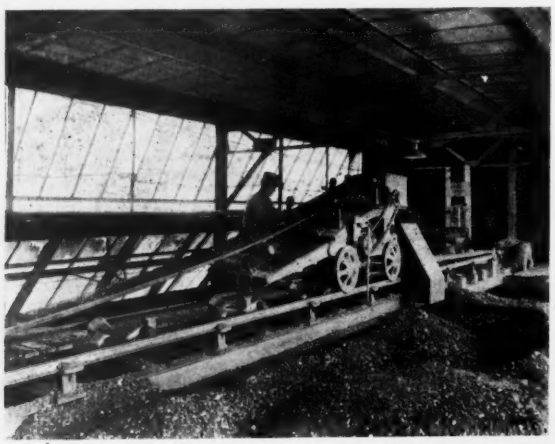


FIG. 11. INTERIOR VIEW OF CRUSHER HOUSE

sists of two turbine-driven units, each of Westinghouse make, rated at 5000 kv.a. and designed to deliver current at 2300-v., three-phase, 60 cycles. Excitation for these may be obtained either from a 50-kw. 125-v. generator driven by and direct connected to a 75-hp. electric motor or from a machine of like rating operated through reduction gearing by a Westinghouse steam turbine.

Both prime movers operate condensing, Westinghouse-Leblanc jet condensers having been installed in the basement of the turbine room for that purpose.

Water for condensing is taken from the river through a screened concrete intake box, from where it flows into a cylindrical cold well which directly connects with a 30-in. line equipped with a foot valve of like size at the suction end and terminating in a header made up of 30 and 20-in. sections and reducing angles which feed the mixing chambers of the condensers by means of 20-in. branch leads. Valves placed in these branches allow the cutting out of either unit should occasion in operating conditions so require.

After having passed through the condenser the injection water, together with the condensed steam, is discharged through an 18-in. lead and an 18 by 42 by 48-in. double ell into a circular concrete pipe which conducts it to the hot well from where it is taken as required for re-use.

The switchboard illustrated in Fig. 1 is built up of 12 black slate panels, which serve in the order shown from left to right the two installed exciters, future exciters, regulating equipment, station auxiliary equipment, the two main generators, future generators, totalizing instruments, the transformers, the double outgoing line and the single (future double) outgoing lines.

All current generated, except that used for station lighting and the operation of auxiliary equipment and which is reduced in voltage by three 15 kv. a., 2200 to 110 and 220-v. transformers is stepped up to 44,000 v. This is accomplished by means of two banks of three transformers each, each transformer being rated at 1500 kv. a., 22,000/44,000—2300 v. with four approximately 2½ per cent reduced capacity taps in the high tension sides and connected in closed delta, a scheme providing continuous operation should any one of the units break down. In such event, however, the set would be capable of delivering but 66 2/3 per cent of its rated capacity.

The transformers and the concrete bus structure are located on the first floor of the switch house directly to the rear of the switchboard.

On the second floor of the switch house are the high tension switches, of which there are four, each rated at 300 amp., 45,000 v. Two of these connect with the high-tension sides of the transformers and two to the high-tension lines.

Two sets of electrolytic lightning arresters, one for

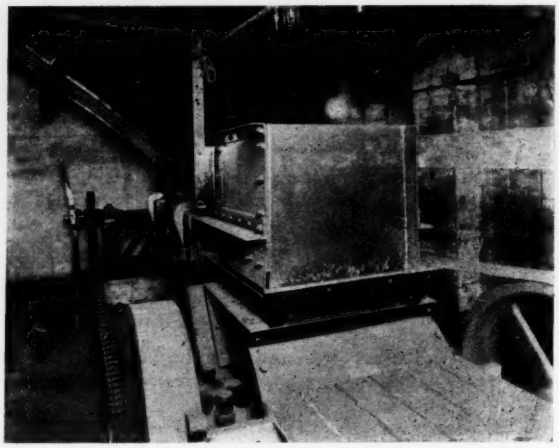


FIG. 12. HEAD END OF CONVEYOR

each outgoing transmission line, are placed on the roof of the building.

The Bureau of Foreign and Domestic Commerce, Washington, D. C., reports that a company in India wishes to purchase 500 220-v. direct-current three or four-blade ceiling fans, 5000 32-candlepower metallic filament lamps, 5000 lamp sockets, 6000 switches, 5000 fuseless ceiling rosettes, and 9000 line fuse boxes, all of 220 v.; 30 miles No. 18 rubber-covered copper wire, 20 miles No. 16 rubber-covered copper wire, 4 miles No. 7/20 rubber-covered copper cable, and one mile of flexible lamp cord. Terms, cash against shipping documents. Reference. In writing the Bureau, refer to opportunity 27,349.

We are now turning out 5000 Browning machine guns a week, 60,000 Enfield-Springfield rifles a week, and have plans under way for manufacturing 500 a month of the French 75s after Jan. 1, 1919, 200 of the 6-in. sea coast gun and 100 of the 240-m.m. howitzer.

Pressure Losses in Steam Plants

CAUSES OF PRESSURE LOSSES; DISTINCTION BETWEEN LOSSES DUE TO THROTTLING AND RADIATION. BY R. S. HAWLEY

WHEN steam flows through a pipe or passage of any kind, it is always accompanied by a drop in pressure. Perhaps it would be better stated that a drop in pressure will cause steam to flow, and it will not flow unless there is a pressure drop. Steam can not pass from one point to another without a change in pressure any more than water can flow without a change in elevation.

The velocity of steam will be largely determined by the pressure drop. The greater the drop the greater the velocity in a pipe and consequently the greater will be the weight of steam flowing per unit of time. Therefore if we wish to limit the pressure drop we must also limit the velocity or increase the diameter of pipe in order to have an equal weight of steam discharged. It follows, then, that with a high velocity the same weight of steam would be discharged through a smaller diameter of pipe, but we would have a greater drop in pressure.

In its passage through pipe or fittings, steam meets resistance because of friction with the surfaces. The amount of friction depends upon the condition of the inside of the pipe, whether rough or smooth, the length of pipe, the velocity of the steam, the number of bends and any obstruction. Between boiler and engine (see chart) this resistance may be encountered in the dry pipe, control valves, fittings, superheater, steam separator and throttle in addition to the pipe friction. Energy is required to overcome this resistance and this energy will be in the form of pressure and must come from the steam itself; consequently a drop in pressure will result. Where the flow is not restricted and the path is short and direct, this drop will not be more than a few pounds; but where the transmission line is long and the pipe is too small or the flow restricted, the drop may be as high as 20 to 25 lb. and represent considerable loss. Any reduction in pressure gives an increased volume per pound of steam flowing. This increase in volume necessitates an increased velocity in order to discharge the same weight of steam. This causes an added friction loss and a greater drop in pressure. This principle is illustrated in Fig. 1.

Suppose 1000 lb. per minute of dry steam flow through pipe AB of 12 in. diameter. From a to b the average pressure is 150 lb., from b to c 140 lb., and from c to d 130 lb. per sq. in. absolute. The average velocity through ab will be found to be 3840 ft. per min. The volume of one pound of steam at 150 lb. pressure is 3.012 cu. ft. (specific volume). Now, at 140 lb. the volume per pound is 3.219 and at 130 lb. is 3.452 cu. ft. The corresponding velocities would be 4100 and 4520 ft. per minute, assuming that no other change occurred in the steam.

This serves only as an illustration. What would actually occur is a constant drop in pressure and a constant increase in velocity for the same weight of steam flowing; but while the pressure is dropping, the steam is undergoing a change in condition other than the increase in volume.

SUPERHEATING BY THROTTLING

ANY SUDDEN reduction in the pressure of steam by restricting its flow is called "throttling." Referring again to Fig. 1, suppose at the point b the steam is suddenly throttled from a pressure of 150 to 140 lb. and no heat is lost. Since there is less total heat in a pound of dry saturated steam at 140 lb. than at 150 lb., there must now be an excess of heat at the lower pressure. This excess heat will go towards raising the temperature or superheating at the lower pressure. If the steam had contained a percentage of moisture, this would first be evaporated before any superheating could take place.

Practically in a steam line there will be little superheating effect because of the small drop in pressure, and further because of the effect of radiation. Steam is not throttled suddenly except in the drypipe and in the throttle or reducing valve, so that any superheating effect would usually be offset by radiation. Radiation is a direct loss of heat and we should distinguish between this and the *loss of available heat* due to pressure drop.

Drop in pressure causes a loss in the amount of energy or heat available for doing useful work in the engine.

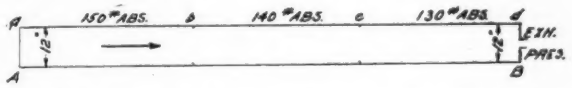


FIG. 1. GRAPHIC REPRESENTATION OF THE PRINCIPLE OF PRESSURE DROP

Every engineer knows that, other things being equal, more work can be done by steam at high pressure than at low pressure. This may be illustrated by considering an extreme case where at d, Fig. 1, steam is suddenly throttled to exhaust pressure with no direct loss of heat. The steam would increase enormously in volume and would have the same total heat content, but its capacity for doing useful work in an engine would be practically exhausted.

LOSS DUE TO THROTTLING

THE ACTUAL LOSS in available energy due to pressure drop can be calculated if the conditions are known. This loss in itself will be relatively small with the usual small pressure drop in pipe lines. For example, if the initial pressure of steam is reduced from 200 to 160 lb. per square inch absolute and the absolute back pressure of the engine is 2 lb. absolute, the loss in available energy per pound of steam is about 13 B.t.u., which is about 3½ per cent of the total available heat under those conditions. If the pressure is reduced from 160 to 90 lb. with the same back pressure as before, the loss in available energy is 35 B.t.u. per pound of steam, or about 9 per cent of the original. If dry steam at 200 lb. initial pressure is reduced to 50 lb. and the back pressure is atmospheric, the loss is nearly 100 B.t.u. The extent of the loss depends upon both the initial pressure and the final pressure to which the steam is to be expanded and becomes relatively greater at the lower pressures. The

calculations involve an application of the laws or thermodynamics and are omitted here.

In considering drop in pressure and the loss due to it, we should also consider loss due to radiation. This loss is direct and depends upon the amount of pipe surface, the pipe covering and the difference in temperature of steam and the surrounding air. Radiation loss and also the initial cost of pipe and pipe-covering increase as the diameter increases, but pressure drop becomes less with the increase in diameter. Both represent losses to the plant. A point may be found where the loss by drop in pressure is practically equal to the loss due to radiation and increased cost of pipe. This would be the economical drop for the plant. What is of greatest importance is that correct pressure be maintained at the throttle valve. A slight increase in the working pressure of the boiler will allow for a drop in pressure and still leave a correct throttle pressure.

A quite common occurrence in power plants is the use of power units each requiring a different throttle pressure and all taking steam from the same main. The boiler pressure must, of course, be higher than the highest throttle pressure. Such an arrangement is not economical and would not be tolerated in large modern power plants where boiler and engine are designed for operation with a predetermined drop in pressure.

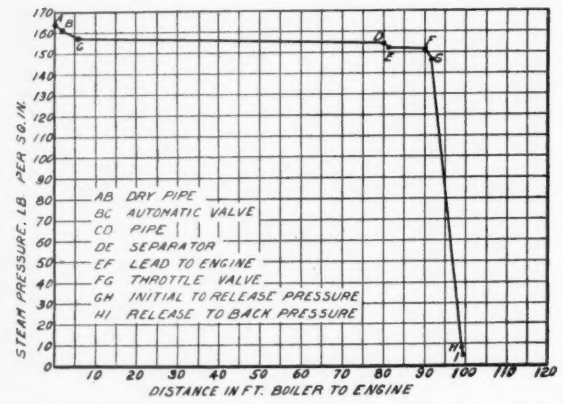


FIG. 2. CHART REPRESENTING PRESSURE DROP IN A POWER PLANT

Pressure Drop from Throttle to Exhaust

In a reciprocating engine the effect of "wiredrawing" or "throttling" of steam due to the resistance of ports and valves decreases the effective initial pressure and raises the back pressure. This cuts down the range of expansion and the energy available for doing work. A certain amount of this resistance cannot be eliminated because of the practical necessity of limiting the size of ports. Only correct points of design can reduce the necessary loss to a minimum. Correct setting of the valves will eliminate the unnecessary part of this loss.

In the condensing engine the degree of vacuum should be given close attention. Correct vacuum is of relatively greater importance in turbine operation than in engine operation for the reason that steam expands in the turbine from initial pressure to condenser pressure, while in the engine the pressure at release is usually several pounds above condenser pressure. Decreasing the back pressure in the cylinder below the pressure at the point of release serves only to increase the mean effective pressure and the indicated horsepower, but does not increase the number of expansions in the cylinder.

It is generally understood that a vacuum of 26 in. of mercury (referred to a 30-in. barometer reading) is as high as can be economically maintained in the reciprocating engine. The reason for this is not difficult to understand. The volume of a pound of steam increases rapidly at the lower pressures. See Table:

VOLUME OF 1 LB. OF DRY SATURATED STEAM

Vacuum, inches mercury	Volume, cubic feet per lb.
26	176
27	250
28	342
29	667

The volume of 1 lb. of dry saturated steam at 200 lb. absolute pressure is 2.29 cu. ft. The difficulty of attempting to expand steam in the cylinders of an engine to a vacuum of 26 in. is at once seen when we consider the enormous size of cylinders that would be required to handle the volume of steam at the low pressures. For this reason, as previously stated, the pressure at release is several pounds higher than the pressure in the condenser. This does not, of course, limit the degree of vacuum, but the gain becomes less relatively as the vacuum is increased and attempts to increase the vacuum beyond 26 in. have usually shown no higher economy in the plant.

In the turbine the steam is expanded more nearly to condenser pressure and enters the condenser with little resistance. This results in higher efficiency because of the increased range of pressure and accounts largely for the very low steam consumption in recent installations of large turbines. Experiments to determine the increase in economy for higher degrees of vacuum seem to give results about as follows:

From 25 to 26 in. of mercury, a reduction in steam consumption of 4 to 5 per cent, from 26 to 27 in. 5 to 6 per cent, from 27 to 28 in. 6 to 7 per cent, and from 28 to 29 in. 7 to 10 per cent (average figures).

Practically a point is reached usually between 28 and 28½ in. where the gain in economy is offset by the increased cost of condensing apparatus and cooling water. Unless the supply of cooling water is large and the temperature is low, it becomes practically impossible to maintain a vacuum of 28 or 28½ in. We should keep in mind, however, that an increase in vacuum of even a small amount may mean a considerable saving of steam and fuel in a year's time.

Formulas

In reciprocating engine practice a velocity of steam in pipe lines of 6000 ft. per minute is a common standard. The drop in pressure corresponding to this velocity will vary from ½ lb. to 2 lb. per 100 ft. of pipe. With higher pressures a higher velocity and a corresponding larger drop in pressure will be found advantageous. In turbine practice velocities of 8000 to 10,000 ft. per min. are common and in very large plants it has been found necessary to employ much greater velocities in order to handle the large volumes of steam without installing pipes of excessive diameter.

The relation between velocity, pressure drop, diameter and length of pipe is shown by any one of several pipe formulas. Professor H. V. Carpenter gives the following relations:

$$V = 16{,}050 \sqrt{\frac{P\,d}{y\,L\left(1 + \frac{3.6}{d}\right)}}$$

where V = velocity of steam in ft. per minute.
d = diameter of pipe in inches.
L = length of pipe in feet.
P = drop in pressure in pounds per square inch.
y = mean density of steam in pounds per cubic foot.

The length of straight pipe which is equivalent to the resistance of one standard 90-deg. elbow may be found from Briggs' formula:

$$L = 76\,d \div \left(1 + \frac{3.6}{d}\right)$$

and for a globe valve:

$$L = 144\,d \div \left(1 + \frac{3.6}{d}\right)$$

where
L = length of pipe in inches.
d = diameter of pipe in inches.

Power Plants and the Fuel Administration

RATING OF POWER PLANT BASED ON ANSWERS TO QUESTIONNAIRE; RECOMMENDATIONS AND AIDS GIVEN OPERATORS. BY A. P. CONNOR, WASHINGTON CORRESPONDENT

THE Fuel Administration has issued another official questionnaire upon which as answered depends the rating of your plant. A warning to readers is to give the matter more than ordinary attention and answer the questionnaire when and how the Fuel Administration directs in its circular instructions.

WHAT TO DO

THE SEQUENCE of actions in the matter of the questionnaire should be as follows:

(1) Read over the questionnaire when received and get a full idea of what it asks for and what each question covers.

(2) Then look over the plant in every particular that the questions go into.

(3) Make each and every repair that affects the efficiency of the plant and which is covered in the questions, or make the proper provisions.

(4) Then answer the questions fully and properly and accurately.

(5) Then forward your answered questionnaire to the Fuel Administration, and do this within 15 days of the receipt of the questionnaire.

WHAT THE ANSWERING OF THE QUESTIONNAIRE WILL MEAN

THE QUESTIONNAIRE, while mainly intended to find out what the Fuel Administration desires to know, indicates in a very accurate manner just what it recommends, and as the Fuel Administration is much in power in the situation, it would seem to be the very best policy to conform to its wishes by following the hints given indirectly by the questionnaire.

If the questionnaire is not returned within 15 days from its issuance to a power plant, that plant and its interests are put in the lowest class, namely, class 5, and remain there until it is heard from. To be placed in this class is bad for the power plant and may lead to results and conditions that will deprive it of many benefits that it should otherwise have. Excuses for lateness in answering do not look well and no occasion should arise for the making of them, unless absolutely unavoidable.

After the report is received, the power plant will be given a preliminary rating, and it will be advised as to what its rating is. Inspectors will personally visit your plant and investigate the conditions and make their own reports, and any efforts made in the plant towards the saving of fuel and avoiding of wastes will be given proper consideration and will go towards the advancement of the rating to a higher grade, if the plant is deemed to deserve it.

The questionnaire will also serve to rate the desirability of apportioning coal to a plant, particularly in case of shortage.

If any questionnaires are received which are not accurately answered, they will be checked up when the inspector compares the plant with the answers, and the rating will be adjusted accordingly.

If the inaccuracy is gross, it will tend to make the future reports from the plant subject to close scrutiny and put it in an unfavorable light, and perhaps subject it to reprimand. It is safe to say that the Fuel Administration has no hesitation in delivering a substantial reprimand whenever and wherever it is deserved, and there should be no cause for one in this case, and there appears no need for the occasion on the part of any plant.

The various ratings of the various questions are indicated on the questionnaire, and these ratings indicate the respective importance of the portions of the plants to which they refer.

A certain amount of allowance will be given to a plant for difficulty in the obtaining of new apparatus; but the best plan would be to make sure that such apparatus cannot be obtained before permitting it to be made a definite reason for not having it—where it is needed badly.

RECOMMENDATIONS

THE FUEL ADMINISTRATION has gone to the trouble and expense of outlining in definite and clear language what it recommends, and has put it in a form to be placed in a prominent place in the power plant. The recommendations are practical, and, what is more important, they will be those on which the rating of the power plant will be based and should therefore be acted upon. It is not enough to place the notice referring to them in a conspicuous location and then trust that every member of the plant will read them; it should be the aim to have every member read it over carefully under

the personal supervision of the chief of the power plant, and he should be advised of the importance of co-operating with the recommendations, and the seriousness of not complying with them. As a matter of carefulness, the notice should be framed properly and kept clean. The next point of value is to suggest that each member of the plant get a good general idea of the apparatus that is urged upon plants, the methods, and the reason "why" such are emphasized.

The questionnaire is made in form large enough to permit a complete answering of questions, and there is plenty of space allowed for a statement of any special conditions; in fact the questionnaire is the best the writer has seen among those that have been made up to date in the matter. As a last suggestion, it would be appropriate to have the answers typewritten on the form, and have it turned in as clean as possible.

RECOMMENDATIONS OF THE FUEL ADMINISTRATION

POST THIS NOTICE in Your POWER PLANT

Your Coal Supply Will Depend on Your Compliance With These Recommendations.

THE UNITED STATES FUEL ADMINISTRATION

makes the following recommendations concerning the generation and use of power, light and heat. The alphabetical reference to each subject corresponds to the questions in the accompanying Questionnaire.

(A) FUEL:
That provision be made for weighing and recording of the fuel used each shift or day.
EXPLANATION:
Keep daily record of coal consumption, recording such weights in the boiler room. (See United States Fuel Administration Bulletin on "Boiler Room Accounting Systems"). A low rate of combustion per square foot of grate surface means waste. The coal burned per hour, divided by the grate surface in active use will give pounds of coal per square foot of grate surface per hour. For hand-fired furnaces with soft coal, this figure should not be less than 15 to 20, and for steam sizes of anthracite, 10 to 15. Reduce the number of boilers or grate surface to obtain the proper rate of combustion.

(B) WATER:
That feed water be heated, measured and regulated.
EXPLANATION:
Keep daily records of feed water consumption. This, with record of coal, permits calculation of the water evaporated per pound of coal. Use exhaust steam for heating feed water, and save one percent of fuel for each 10 to 11 degrees Fahrenheit rise in temperature of the water, also increase steaming rate of boilers. Steady or regulated feed of water is a source of economy.

(C) AIR SUPPLY:
That provision be made for a correct air supply and a convenient means for the measurement and control of the draft.
EXPLANATION:
Determine the air pressure to the furnace with draft gauges, connected to the furnace or breeching. It eliminates guesswork and insures a proper supply for combustion. Regulate draft on all the boilers with main flue damper, after setting individual dampers on each. Check combustion by analyzing the flue gases. Suitable instruments are available at from $15 to $25.00. By this method admission of excess air may be readily detected, the skill of the fireman known and waste of fuel prevented.

(D) CLEANING AND HEATING SURFACES.
That provision be made to keep boiler surfaces clean inside and out.
EXPLANATION:
Tubes should be frequently and thoroughly cleaned and the feed water properly treated to prevent scale formation upon the inside of the boiler or tubes. (See United States Fuel Administration Bulletin on "Water Treatment for Steam Boilers.")

(E) BOILER AND FURNACE SETTING:
That the grates be in good repair, that settings, breeching and access doors be free from air leakage, and that surfaces wasting heat be covered with insulation of ample thickness.
EXPLANATION:
Do not allow burnt-out or broken grates. They waste coal into the ash pit and the surplus air causes holes and clinker. Stop cracks in the boiler setting, door frames, etc., with specially prepared material for this purpose. Badly warped or cracked fire doors should be repaired or replaced. Air leaks in brick work and general setting can be detected with a torch. If leakage exists, the flame will be drawn in.

(F) INSULATION:
That the surfaces of steam piping, drums and feed-water heaters which waste heat by radiation be properly covered with insulating material.
EXPLANATION:
Covering these surfaces with 85% magnesia or similar material, at least 2" thick, will save 80% of the heat.

(G) ENGINE ROOM AND HEATING SYSTEMS:
That exhaust steam be utilized wherever possible instead of direct steam from the boilers. The plant should be so designed and operated, so far as possible, that no more exhaust steam will be produced than can be used.
EXPLANATION:
Use exhaust steam for heating feed water, buildings and general process work. Exhaust steam from the engine contains about 90% of the heat in the live steam. Never allow exhaust steam to escape to the atmosphere when it can be used for any useful purpose and avoid waste.

(H) SUPERVISION:
That a committee of employees be detailed on fuel conservation in the boiler and engine rooms and for the work of fuel, power and light conservation outside of the power plant.
EXPLANATION:
Plant owners should appoint an individual or a committee to study conditions in the boiler and engine room and throughout the plant. The duties should be the organization of and carrying out methods for the prevention of waste. The members of this committee, to be changed from time to time, and where feasible, some form of bonus arrangement made for those most active in accomplishing results. Records should be kept on a weekly or monthly basis showing just what has been accomplished by the activities of this committee.

The wide variation in conditions surrounding the use of power, light and heat is against any arbitrary rulings governing shop operations. The following points, however, should in a general way be of assistance to your committee:

First: Eliminate operation of motors when machines are idle, by means of convenient switches.
Second: Group machines, so that driving motors or engines operate at their highest efficiency.
Third: See that all bearings are regularly oiled and inspected to correct alignment and insure operation with least friction.
Fourth: Eliminate belt slippage, so far as possible.
Fifth: Stagger manufacturing operations so that peak loads will be flattened as much as possible.
Sixth: In alternating current installations, provide means for improving the power-factor conditions.
Seventh: Reduce elevator service to a minimum.
Eighth: Reduce use of hot water to a minimum.
Ninth: Stop all leakage in water spigots, pipes, etc.
Tenth: Reduce number of lights used wherever practicable. Reduce candle power of lights used wherever possible.
Eleventh: Eliminate use of carbon lamps and replace with mazda or other high efficiency lamps.
Twelfth: Eliminate arc lamps by using large lighting units of more efficient type.
Thirteenth: Provide a thermometer in different parts of the shop and make arrangements to keep the temperature within reasonable limits.
Fourteenth: Eliminate heating radiators or piping not in actual use.
Fifteenth: Wherever possible provide storm doors and storm windows on all openings, used during winter months.

Many other ways to effect conservation will, no doubt, be devised by your committee, and it is suggested that emphasis be laid on the fact that no saving is too small to be given consideration.

The Administration has planned an advisory board of competent consulting engineers attached to the office of the State Administrative Engineer, and there will also be attached to his office expert firemen and operating engineers.

Further, the United States Fuel Administration has prepared a fifty-minute film of moving pictures, showing good and bad operation in the steam boiler plants, methods of testing boiler fuels, etc., which will be exhibited with lectures in all industrial communities. It is also preparing a series of official bulletins written for the purpose of informing boiler plant operators on the various phases of steam and fuel economics. These bulletins include the following:

1—Boiler and Furnace Testing.
2—Flue Gas Analysis.
3—Saving Steam in Heating Systems.
4—Boiler Room Accounting Systems.
5—Saving Steam and Fuel in Industrial Plants.
6—Burning Fine Sizes of Anthracite.
7—Boiler Water Treatment.
8—Oil Burning.
9—Stoker Operation.

Further information concerning this publicity and educational work and extra copies of the Questionnaire may be obtained from the State Administrative Engineer.

New Features

With a progressiveness that is in full consistency with the present age, and with a policy of constructiveness attached to its system of supervision, the Fuel Administration has taken steps that will be of interest and value to those in the power plant professions. It has made up a series of moving picture subjects showing in very attractive form the various ways of operating a power plant, both properly and improperly; also methods for testing boilers; the testing of fuels and many other valuable and instructive features that will appeal to those on whom the success of the plant depends. The bureau is also preparing a number of instruction books or bulletins treating of the following subjects: Boiler and Furnace Testing. (2) Flue Gas Analysis. (3) Saving Steam in Heating Systems. (4) Boiler Room Accounting Systems. (5) Saving Steam and Fuel in Industrial Plants. (6) Burning Fine Sizes of Anthracite. (7) Boiler-Water Treatment. (8) Oil Burning. (9) Stoker Operation.

These bulletins will be distributed free or at a very low cost.

In addition there has been established a list of competent engineers for each state and is available for the use of the local administrations. These features have all taken an active form and it is expected that they will be further augmented, so that the future may outline many things that will be of interest and benefit to those interested in the power plant, the saving of fuel, and the proper outcome of the war.

Handling Jones Under-Feed Stokers

BUILDING AND BANKING FIRES; PRECAUTIONS TO OBSERVE IN HANDLING FIRE. BY RECEIVER

WHEN building the fire for the first time, or whenever it has been necessary to empty the retort or fuel magazine, the first move is to fill the retort with coal, covering the tuyere blocks and the dead plates on each side of the retort about 2 in.

If we have another boiler running, 2 or 3 shovels of live coal on the tuyere blocks at the front end of the retort will give a good start. If no live coal is available we put shaving and small pieces of wood to kindle with.

As it is desirable to use forced draft with these stokers, the draft is best controlled by having the fan run by an independent engine or motor.

In most plants one or more boilers are always under pressure so steam is available to run the engine, or current obtained from some source to run the motor for fan operation. If we have power to run the fan, we open the dampers in the uptakes, the blasts from the fans discharge into the ashpit and start the fan.

If no power is obtainable to run the fan until the idle boiler will be under pressure, we fire with wood through

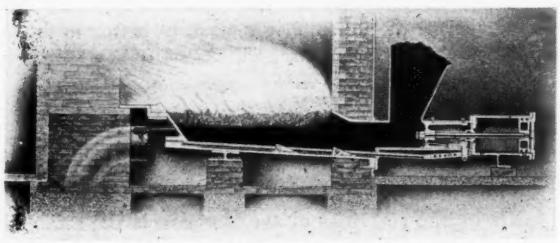


FIG. 1. LONGITUDINAL SECTION THROUGH JONES UNDER-FEED STOKER

the fire doors in the usual way until we have 25 or 30 lb. pressure, which is usually enough to start the fan engine, when the forced draft will cause more rapid combustion and the pressure to rise faster.

While it is possible to raise steam with cold boilers and cold water in a far shorter time than with hand firing, the same caution and care must be used not to force the fires unduly, for the same reasons that plenty of time must be taken in the building of fires with hand firing.

When the surface of the fuel in the retort is burning brightly, the water is drained from the piping leading to the ram steam cylinder, from the Cole automatic valve, the condensation drained from the cylinder and steam turned on to the Cole valve steam chest to warm it up. Then set the feed finger, Fig. 2, in one of the lower feeds, say No. 2 or 3, and start the ram. This will automatically feed the coal to the fire as desired, gradually building the fire up to what your experience dictates to be the proper height.

When considerable ash and clinker have accumulated on the dead plates, and when clinker forms on the tuyere blocks, it shuts off the air to the coal and the result is that the rate of combustion is reduced, the steam pressure falls and to restore normal conditions it is necessary to clean the fire.

When one is accustomed to his load he knows when to begin to burn down the fire, which is best done this way:

Move the finger on the index on the Cole automatic valve that controls the speed of the ram to a lower number so as to decrease the quantity of coal pushed into the retort, the result being that the thickness of the fuel bed becomes less until we have the thickness that will enable us to clean to advantage. Do not shut the feed of coal off entirely and be cautious not to burn the fire so low as to allow live coal to reach the interior of the retort because, if repeated several times, this practice will surely burn out something.

With the blast gate shut and the uptake damper partially closed, we use the slice bar to break up the clinker by running it along the top of the tuyere blocks and the dead plates. When the clinker is sufficiently loose, the bar can be used to work the clinker toward and out

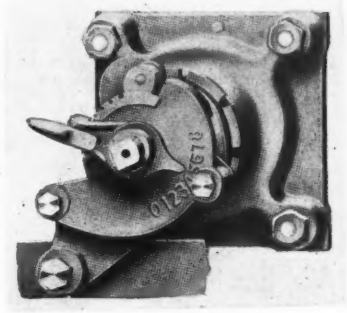


FIG. 2. COLE AUTOMATIC VALVE

of the fire door, or the hook or hoe may be better to pull the clinker out with.

The fine clinker and ash is best removed with the hoe, leaving about 2 in. to protect the dead plates from warping. When the refuse has been removed and it is desired to bank the fire, we can fill the hopper with coal and with the ram in motion force a considerable quantity of green coal into the retort until it rolls over onto the dead plates. We can also control the action of the ram by putting the handle which accompanies the stoker equipments, on the independent valve stem that controls each ram cylinder and rotating the valve, secure the same result as when the feed is automatically controlled. Properly cleaned and banked fires will remain in good condition for 56 hr. with little attention.

To place the fire in service, take the slice bar and insert it into the front of the retort to loosen up the coal when it has coked or baked hard to make the movement of the ram easier to begin with. Then open the damper in the uptake, the air blast gate in the ashpit and if the fan is stopped, start it. In a few minutes the green fuel is incandescent and then set the finger on the automatic valve to admit steam into the ram cylinder to supply coal to the fire as load conditions may demand.

If, through carelessness, a pusher block or pusher rod

in the retort should become burned, due to not maintaining a sufficient quantity of coal in the retort, and thus allowing the fire to enter the retort, it is an easy job to make renewals.

In piping the steam pipe to the ram steam cylinder, a union ought to have been located directly under the ends of the cylinder so the steam pipes may be disconnected at that point. The point A, Fig. 3, is removed, as are also cap screws, holding the ram to the lower half of the boiler front. In some cases it will be better to remove the hopper from the ram case than to move the ram cylinder and ram case from the boiler front. Having removed the coal from the retort, the set screws holding the pusher blocks in position on the pusher rod are slackened when the pusher rod can be pulled through the front.

To assemble the parts after repairs, the reverse operation is followed. To aid in the proper distribution of coal the entire length of the retort, the pusher blocks, Fig. 3, can be changed into several positions, care being taken, however, to put the set screw into the spots on the pusher rod.

Several holes will be found in the straps under the ram case that are located there to enable the bolt in the pusher rod to be inserted to adjust the travel of the pusher rod.

Should the tuyere blocks become burned, which may result from burning the fire too low previous to cleaning

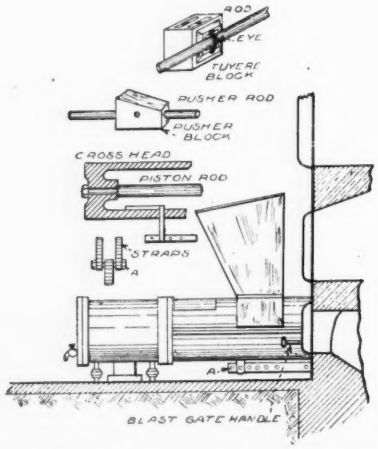


FIG. 3. DETAILS OF UNDER-FEED STOKER

or running too light, all that is necessary to make a replacement of the block is to withdraw the rod, 1, Fig. 4, through the front and entering the furnace lift out the damaged block; put in a new one and replace the rod.

It is essential to have the dead plates located on each side of the retort covered with coal and ash to insure ample protection against warping. This plate is heavily ribbed, and when the fire is cleaned care must be exercised to keep about 2 in. of ash over these dead plates. Should it be necessary to renew one, remove the ram cylinder and ram case as shown and then remove the lower half of the cast-iron boiler front, to enable the dead plate to be taken out. This is usually an expensive repair, since it is generally necessary to take down and replace the firebrick over the fire doors protecting the cast-iron front to enable one to remove the nuts on the bolts which unite the lower half front with the upper.

In filling the hopper with coal, care should be taken not to allow pieces of wood or metal to enter as it is quite likely they will become caught between the ram and the inner end of the ram case and prevent the onward movement of the ram. In many instances a trowel or small shovel can be used to dig the coal out of the hopper, and again it may be better to unbolt the hopper where it is

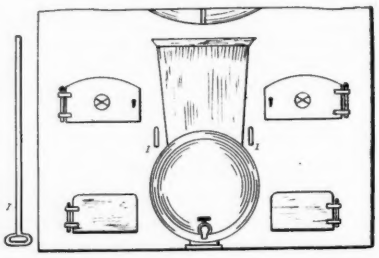


FIG. 4. BOILER FRONT SHOWING LOCATION OF TUYERE BLOCKS, ROD AND ASSEMBLY DETAILS

bolted to the ram case, easily done by removing four small bolts.

To prevent the coal packing in the hopper and the free movement of the ram, it is usually better to let the hopper remain empty after banking the fire, filling it when ready to start the ram in operation.

Registration of Engineers by the Division of Engineering

ONE OF the activities of the Division is the establishment of a record and classification of engineers from which the needs of any employer or plant may be met.

The registration blank provides an easy method of indicating a man's special experience and qualifications, and places him in touch with opportunities for government and civilian employment. For a blank form write to Director of Engineering, 29 So. LaSalle St., Chicago, Ill.

PRODUCTION of bituminous coal during July and August has been greater than for the corresponding months of 1917, but has shown a steady decrease since the high point reached in the week of July 13. For the week of Aug. 10 the production fell below total capacity 9.8 per cent on account of car shortage, 4 per cent on account of labor shortage and 4.2 per cent from mine disability. Car shortage was greatest in Kentucky and Pennsylvania fields, labor shortage in West Virginia, and mine trouble in northern Ohio. The total loss of production is 19 per cent of mine capacity, practically none being due to strikes. This indicates that the situation for next winter is still critical, and every effort should be made to secure and store as large a supply as possible up to one's full needs for the winter season.

IN THE ARTICLE on the Curtis Bros. & Co. wood-burning plant, at Clinton, Iowa, it was mentioned that the National stoker was used. This is made by the M. A. Hofft Co., of Indianapolis, Ind.

Using Navy Compound

SPECIFICATIONS FOR NAVY COMPOUND; METHODS OF MAKING DAILY TESTS OF BOILER WATER; WHEN TO BLOW DOWN BOILER. BY A. C. McHUGH

THE softening and filtering plant in which the feed water is chemically treated and the impurities removed before the water enters the boiler is without doubt the best method of feed water treatment as far as the prevention of scale is concerned. But small or moderate sized plants having such apparatus are comparatively few, other means being adopted to combat scale. Another item that enters the problem is that of corrosion, which may attack a boiler in any of several different ways, i.e., it may act uniformly upon the surface of the boiler plates or it may take the form of local corrosion or pitting, which is by far the most dangerous.

The removal of scale forming matter does not necessarily prevent corrosion; in fact, many boilers have suffered badly from corrosion when using only condensates entirely free from mineral impurities. If a method of treatment were perfected whereby both corrosion and scale formation could be eliminated, two of the most trying power plant problems would be solved.

With the foregoing purpose in view, some stationary plants are now experimenting with a preparation known as Navy Standard boiler compound, so named because of its extensive use in the U. S. Navy. As the water used in naval boilers is mostly free from impurities, the compound is mainly used to prevent corrosion, and Lieutenant Commander Frank Lyon, in a paper appearing in 1912 in the Journal of the American Society of Naval Engineers, states that, "regardless of the water used for feed purposes, any boiler may be protected entirely from corrosion by the use of Navy compound." It would thus appear that one problem was solved, and a study of the ingredients of this compound indicates the possibility of scale prevention also.

The specifications for Navy compound submitted to the chemical companies manufacturing it for the navy require it to show an analysis not less than 76 per cent of anhydrous sodium carbonate, 10 per cent of trisodium phosphate, 1 per cent of dextrine or starch, and enough cutch to supply at least 2 per cent of tannic acid, the remainder to be made up of water or the usual impurities common to the ingredients. It must be thoroughly digested, dried, powdered and well mixed. The sodium carbonate is the active agency in eliminating corrosion while the tannic acid and starch prevent the formation of scale, holding the impurities in suspension. The trisodium phosphate is used to prevent foaming and is not in itself a boiler compound, but as alkaline water is inclined to foam its use is necessary.

The writer has had personal experience in the use of Navy compound in several plants, and a description of the conditions under which it was applied and the results obtained will best illustrate its value. The drums of four water tube boilers were found to be pitting badly and at each inspection the pits seemed to have enlarged; there was also considerable trouble due to a hard scale which was very difficult to remove. The feed water was made up mostly of condensate from the heating system and surface condenser, the remaining 10 to 20 per cent was taken from the city mains and proved to be slightly acidulous. A chemical analysis showed it to contain the following impurities: Silica, 0.98; alum iron oxides, 0.58; calcium carbonate, 3.66; calcium sulphate, 0.57; magnesium carbonate, 2.92; magnesium sulphate, 2.78; with 2.8 grains of sodium chloride, per gallon. Many different compounds had been used with varying results, but none were wholly satisfactory, so it was decided to try the Navy compound.

In order that the desired results may be obtained with Navy compound, it is necessary to make daily tests of the boiler water so that the degree of alkalinity may be known and the compound applied accordingly, i.e., a certain alkalinity is decided upon, generally about 3 per cent of normal for stationary boilers, and the compound is fed to the boilers in such quantities as to hold the alkalinity constant. If the daily test shows the alkalinity to be below the desired degree, more compound is added; if shown to be above, the alkalinity may be lowered either by blowing the boiler or by decreasing the amount used. A little practice will accustom one to the average amount necessary, which should be fed gradually to the hot well, and any deficiency found upon test should be made up by adding compound directly to the boiler by means of a small injector or hand pump. This, of course, applies to plants operating more than one boiler.

The compound is in the form of a reddish brown powder and is readily dissolved in hot water. In the plant in question 3 lb. twice a day was found sufficient, each lot dissolved in a bucket of hot water was poured into a 50-gal. iron tank of warm water and boiled for half an hour by means of a steam jet. As the tank was above the hot well, the mixture was fed through a small connection in the bottom which was so regulated as to require from 6 to 8 hr. to empty the tank. As the impurities are held in suspension, it is necessary to blow the boilers at regular intervals. This removes some of the suspended matter, but also reduces the alkalinity. In this plant one blow a day was found to give best results.

There has been but one case of foaming in considerably over a year's use of the compound, and it is believed this was due more to a large amount of suspended matter than to high alkalinity. Corrosion has been prevented entirely and very little scale is found after a run of 9 weeks, although there is generally enough present in the tubes to make the use of the turbine cleaner necessary. It had been the practice formerly, when using a compound, the greater part of which was soda ash, to use about 12 lb. a day, but 6 lb. of Navy compound was found sufficient. This, and the fact that the Navy compound costs about one-half as much as most of the other compounds on the market, gives it quite an advantage in dollars at the end of the year.

The apparatus necessary for testing the boiler water is made up of two burettes graduated in 0.1 c.c. from 0 to 25 (Note: One cubic centimeter is equivalent to 0.061 cubic inch, or 0.035 ounce) one 50 c.c. measuring flask, one small white porcelain dish, one glass stirring rod, two 1000-c.c. bottles labeled Solution No. 1 and

Solution No. 2, respectively, the first of which is to be filled with a N/2 normal solution of sulphuric acid, and the second with a solution of nitrate of silver, 41.01 grams of silver nitrate crystals dissolved in distilled water enough to make 1000 c.c. of solution; and three small bottles labeled Indicator No. 1, No. 2 and No. 3, respectively.

Indicator No. 1 is made by dissolving 1 gram of methol orange powder and 5 grams of phenolphthalein powder in 500 c.c. of alcohol and adding distilled water enough to make 1000 c.c. of solution; No. 2 is made by dissolving 1 gram potassium chromate in distilled water enough to make 100 c.c. of solution; No. 3 is a N/2 normal solution of caustic soda made by dissolving 20 grams of pure caustic soda in distilled water enough to make 1000 c.c. of solution. The entire outfit, including the solution, can be purchased for about $25. Better results will be obtained if the various solutions are made up by an experienced chemist. All bottles should be kept well corked and the nitrate of silver solution should be kept in a dark place.

To make the test for alkalinity, a quart or so of water is drawn from the boiler and allowed to stand until it has cooled to room temperature. (If the suspended matter has not entirely settled, the sample should be filtered.) Next wash out the porcelain dish and the measuring flask with some of the water and draw off 50 c.c. of water and place it in the dish, adding 4 drops of Indicator No. 1. If the water is alkaline the sample will immediately turn deep red, but if acidulous the color will be a reddish pink. Now fill one of the burettes with solution No. 1 and partly open the cock, allowing it to run out until the lower end below the cock is filled. This is necessary if an accurate reading is desired. Now read the graduation on the burette at the top of the solution and place the dish with the sample under the burette and allow the solution to drop slowly into it, meanwhile stirring continually and watching the sample for a change in color, for as soon as the acid has neutralized the alkali of the sample, it will start to neutralize the indicator, thus changing the color from red to clear, then yellow and then faint pink. As soon as the pink appears close the burette and read the graduation on the burette at the top of the solution. The difference in the two readings represents directly the percentage of alkalinity, i.e., if 2.8 c.c. have been drawn from the burette the alkalinity is said to be 2.8 per cent.

When the feed water is apt to contain salt it is necessary to fest for chlorine. Should the test show the chlorine to run higher than 400 grains per gallon, the blowoff should be used until it is reduced. To make the chlorine test, take the same sample used to determine the alkalinity and add a drop or two of indicator No. 3. This will neutralize the acid in the sample and will turn the sample from pink to clear, or a slight red. Then add 4 drops of indicator No. 2 and after filling the other burette (taking the same precaution to see that the extreme lower end is full, as previously explained), with solution No. 2, read the graduation at the top of the solution and while stirring the sample allow the solution to drop in until the sample turns from a milky yellow to a reddish yellow. Now read the graduation on the burette at the top of the solution, and the difference between the two readings multiplied by 10 will give the number of grains of chlorine per gallon; i.e., if 18.9 c.c. of solution have been drawn off, the chlorine will be 189 grains to the gallon.

In making the test for alkalinity the writer has found that more accurate results are generally obtained by using a weaker solution of sulphuric acid than has been described, the reason being that the sample used may be larger and the change of color more gradual, and thus more easily observed. The solution used in the mentioned plant is a N/10 normal solution of sulphuric acid, and in making the test 100 c.c. of water is used instead of 50 as given for the standard test. With 100 c.c. of water and a N/10 solution the alkalinity is determined by multiplying the difference between the two readings by 0.5. Thus if 4.8 c.c. of solution have been drawn the alkalinity is said to be 4.8×0.5, or 2.4 per cent. To make the chlorine test, half the sample is removed and the test continued as previously described.

There has been considerable discussion as to the effect of an increase in the density of boiler water as results from the use of Navy compound, and it is well to caution the inexperienced user to observe care in preventing an increase in the alkalinity over that necessary for good results. In some cases, an alkalinity less than 3 per cent will be found sufficient; but this point should be established by careful experiments, i.e., the alkalinity should be held at a given strength for a short period, say one week, then the boilers should be opened and the results observed. If found unsatisfactory, another percentage of alkalinity should be tried, and so on, until the desired results are obtained.

Some authorities claim that high alkalinity causes crystallization of iron and steel plates which leads to brittleness at the seams below the water line and results in seam lap cracks which first appear at the surface of the plate and gradually increase in length and depth. Whether the truth of this claim has been fully established, the writer cannot say; but wherever any alkaline compound is used, whether Navy compound or any of the many others upon the market, it would be well to be on the lookout for any indication of lap cracks.

SECRETARY LANE'S committee on industry and education is taking account of the fact that to carry on our war industries, as well as those supplying the needs of civil life, it is essential that a large force must be kept in training for higher scientific and technical work, and teachers must be provided for this purpose. There has been great tendency for the young men in engineering and technical schools to leave and enlist in the fighting forces, and, while this spirit is laudable, it has depleted the source of supply of technical men so that in a few years there will be insufficient numbers to meet the needs of the country.

It is urged, therefore, that young men and women should take heed of this need and apply themselves as enthusiastically to preparing for future work in engineering and scientific lines as do the students in the training camps for work in military lines. Wherever practicable, young men should also join the students' enlisted reserve and prepare for military service so as to be ready for whatever call is most urgent in the future.

Improving Factory Steam Plants—III

ENGINEER'S REPORT OF CONDITIONS FOUND IN PLANT, DESIRABLE REPAIRS AND NEW EQUIPMENT AND RECOMMENDED TESTS. BY H. A. WILCOX

THE report reproduced here almost verbatim is an analysis of the situation in the plant considered in the second article of this series, published in the Aug. 15 issue and is given to show how a big difficulty may be overcome at reasonable expenditure of time and money if the analysis of the difficulty is made carefully enough. All names which would serve to identify the plant in question have been purposely omitted:

The report follows and all names which would serve to identify the plant in question have been purposely omitted:

"May 24, 1917.

"For the past three months, the boiler plant in this mill has been apparently overloaded. During this period, the finished production turned out by the mill has been increased and this has caused a large increase in the amount of steam used. At times, great difficulty has been experienced in keeping the steam pressure on the boilers above 100 lb. The 'standard' steam pressure at this plant is 120 lb. and the safety valves are set to open at 130 lb. The purpose of this report is to review the steam situation and to suggest a definite plan of action for immediately overcoming the above difficulty.

"Steam is supplied by six vertical, fire tube boilers to six Textile Machinery Co. driers, 11 rotary kiers or digesters, three agitators or caustic mixers, a hoisting engine, and the heating system.

"The boilers are numbered from left to right: 1, 2, 3, 4, 5, and 6. Numbers 1, 2, 3, 4, and 5 are duplicates, but number 6 is a little smaller than the others. Following is a table giving the general dimensions of these boilers. Nearly all of the dimensions for boilers 1, 2, 3, 4 and 5 are taken from a blueprint and specifications furnished by the builders. I have been unable to obtain similar information about number 6 so some of the data is somewhat approximate or omitted. Where possible, all figures have been checked by measurement. Hourly quantities were obtained by averaging the Daily Boiler Room Logs and the cost sheets of this plant for a considerable period of time.

"From recent tests made at this plant and at plant X, I find that the driers demand from 90 to 110 boiler horsepower per hour each and that the kiers take from 80 to 100 boiler horsepower per hour each. In all probability, 50 to 75 boiler horsepower will cover all remaining steam requirements.

"Ordinarily six driers and six kiers are using steam at the same time at this plant. Based on the above figures, this means a minimum steam consumption of 1070 boiler horsepower per hour and a maximum of 1335 boiler horsepower per hour. This load fluctuation is dependent largely upon stock and atmospheric conditions. With everything running on schedule, and with favorable stock and atmospheric conditions, the boilers can maintain 120 lb. pressure. With the above conditions unfavorable, it is necessary to shut off part of the load at times in order to maintain 120 lb. pressure. To supply the maximum steam demand continuously, it is necessary to run the boilers at full rating all the time and this is not being done at present.

"My analysis of the situation is as follows:

"1. The ratio of heating surface to grate surface (73 and 25) is much too high—standard practice on this type of boiler calling for 48 and 16.

"2. The ratio of heating surface to rated boiler horsepower (11.6) is ample—standard practice calling for 11.5.

"3. The ratio of grate surface to rated boiler horsepower (0.14x0.165) is too small—standard practice calling for 0.23.

"4. The average evaporation (10.3) is exceedingly good.

"5. The rate of combustion 18 lb. (pounds of coal per square foot of grate) is about as high as can be maintained with natural draft.

"6. The boilers are at present developing one horsepower from every 3.4 lb. of coal burned, standard practice calling for about 5 lb. of coal per horsepower-hour.

"Considering these facts, the natural solution is to burn *more* coal per square foot of grate and so develop *more* horsepower.

"From personal observation of the fires carried, the cost sheets, analysis of the flue gases, the grate ratios noted above under 1 and 3, and considering the present rate of combustion under 5, I have concluded that we cannot materially increase the rate of combustion with the present draft and grate surface.

"We have two possibilities for increasing the boiler horsepower developed per hour:

"(A) Install an additional boiler.

"(B) Increase the present rate of combustion.

"(A) An additional boiler, large enough to serve the purpose, would cost, installed, about $3500 and it would probably, at best, require at least six weeks for its complete installation. Such an additional boiler would have to be placed at the west end of the boiler room. This boiler would be at the tail end of the flue, so it is doubtful if the present stack would produce sufficient draft on this boiler to run it efficiently. Therefore the installation of an additional boiler would probably involve the erection of a new stack, at the west end of the boiler room, costing about $3000.

"The present boilers are developing on the average about 80 per cent rating. There is no apparent reason why these boilers cannot be easily forced to 115 per cent rating, corresponding to 1541 hp. or higher if necessary. It is therefore logical to assume that we ought to utilize our present resources to their full extent before seriously considering the installation of a new boiler.

"(B) The present stack is 100 ft. high and 78 in. in diameter. Theoretically this stack is capable of taking care of 1000 boiler horsepower per hour, based on a consumption of 5 lb. of coal per horsepower-hour. This is equal to the consumption of 5000 lb. of coal per hour. If the present boilers are forced (at the present rate of combustion) to 115 per cent rating, they will require the combustion of $2.4 \times 1541 = 5240$ lb. of coal per hour. This would not overload the stack to any extent,

so an increase in the stack capacity for this purpose would seem entirely unnecessary.

"There remain two ways for increasing the present rate of combustion:

"First—Increase the grate surface per boiler so that more coal may be burned, without increasing the amount of coal burned per square foot of grate. This does not appear to be feasible, so I have disregarded it.

"Second—Install forced draft. Before going into a discussion of this proposition, it will be necessary to discuss briefly the coal situation. I am informed by Mr. X that all of the inter-related plants for which he buys coal, this plant included, require about 10,000 tons of soft coal per month. Mr. X states that he has contracts for about 2000 tons per month upon which he can depend. This coal costs between $7 and $8 per ton delivered. The remaining 8000 tons per month will probably have to be purchased in the open market. The *present* price in the open market for soft coal is between $10 and $12 per ton delivered and all indications are that this price will remain the same or be higher for an indefinite period. Mr. X has a contract for about 65,000 tons of buckwheat at $4.55 per ton delivered and the entire amount must be received before snow flies. At the present time, this coal can be delivered so fast that the facilities for receiving it are taxed to their utmost. If, then, by installing forced draft under the boilers at *this* plant, we find that we can burn a mixture of half buckwheat and half soft coal, will it not prove a saving, besides lessening the requirements of this plant for soft coal to the benefit of the other plants? At the present rate of combustion this plant is burning about 38.2 tons of soft coal every 24 hr. At the minimum price of this coal in the open market, $10 a ton, this would amount to $380 a day. Assuming, from past experience, that a half and half mixture would require 25 per cent more coal per day, we have a new demand for 47.8 tons per day for the present horsepower developed. Half of this (23.9 tons) would be buckwheat at $4.55 per ton, the balance being soft coal at $10 a ton. Then the cost of coal for 24 hr. would be: Buckwheat $108.75, soft $239. Total $347.25, or a clear saving of $32.25 a day. Besides (38.2—23.9 or) 14.3 tons of soft coal would be released for use in one of the other plants. These figures are all based on *present* rates of combustions, but would probably not alter materially at higher rates. In answer to my inquiries from two of the leading firms manufacturing blowers for forced draft, I have been informed that they would much rather burn a mixture of half and half or a mixture even weaker in soft coal than to use clear soft coal.

"The A, B, C Co. of Y positively guarantee that 130 per cent rating can be obtained from these boilers by the use of their turbine-driven individual blowers at an expenditure of 1½ per cent of the total steam generated for driving the blowers. This would mean that the boilers would develop 1742 boiler horsepower, less 26 horsepower for driving the blowers, which equals 1716 net horsepower. This figure is so far in excess of present steam requirements that we could easily drop a boiler for cleaning and repairs every day and still hold the desired pressure. This would enable us to give far better care to the boilers and would abolish the Sunday morning shutdowns and hurried washing of boilers, together with the loss of finished production during Sunday morning shutdowns. Blowers suitable to produce the above results can be purchased for $200 each and six of them would be needed, costing in all $1200 plus about $300 for express, installation, etc. The entire six blowers would be controlled by a balanced steam valve, actuated by the present damper regulator. This steam valve is included in the price for the blowers. Part of the exhaust from the turbines driving blowers would go into the ash pits and help to rot the clinker, so that this annoyance would be lessened; the balance of the exhaust going to the feed water heater.

"By having six individual units, a breakdown of one unit does not affect the other five boilers as would be the case in using one large blower with ducts to each boiler. Shipment of the blowers could be made at once, while a large fan with engine or motor would probably cause delay to say nothing of the cost of the ducts. There are numerous other minor points in favor of the installation of forced draft, but it does not seem necessary to enumerate them at the present time.

"Attached to this report will be found a copy of the proposal of the blower company for installing blowers, as mentioned above.

"I have a quotation from the D. E. F. Co. on similar apparatus, but it is out of the question on account of price and delivery.

SUMAMRY

"THE present boilers are not overloaded.

"The present stack is not overloaded.

"The necessary horsepower is not being developed by the boilers.

"The ratio of heating surface to grate surface is too high.

"To develop the required horsepower, it will be necessary either to install an additional boiler, or to produce more draft by means of a new stack; or by an addition to the height of the present stack (out of the question on account of time and price); or to produce more draft by the use of blowers.

"The use of blowers is for a number of reasons, as outlined previously, the best method to use. I may say that the use of buckwheat may involve a change in the grate openings, but this can be done at reasonable expense and we would not have to make an increase in the present firing force.

"I therefore recommend:

"(1) That a complete evaporative test or tests be run on number 4 boiler under present, natural, running conditions, to determine what the boiler is doing now.

"(2) That one number 16 ———— blower be ordered *immediately* for installation under No. 4 boiler, after the above tests are over.

"(3) That another test or tests be run (with the blower installed) to prove up the statements made in this report and the guarantees of the blower company.

"(4) If these last tests prove successful, similar blowers should at once be installed under the remaining boilers.

"I am firmly convinced even now, that the installation of these blowers will overcome our present trouble with low steam pressure; will make ample provision for future plant expansion, and will enable us to take better care of the boilers (by dropping one boiler for cleaning

every day), thereby lessening our scale troubles and repair expense; and will prove an actual saving in money by enabling us to burn a mixture of buckwheat and soft coal.

"(Signed) H. A. WILCOX."

Copy of proposal for installing individual steam turbine driven blowers under boilers at this plant:

"May 22, 1917.

"As agreed in our conversation of May 21, I am sending you a proposition as to the installation of the ——— blowers on the boiler plant under your control.

"First—We will ship one 16-in. blower on a 30-day trial to be installed on any boiler you may name and a test taken to prove the results obtained by the use of the blower.

"The writer's verbal guarantee to you of over capacity was 50 per cent, but after taking it up with our Mr. ——— I would rather put this guarantee down as an increase of 30 per cent. There is no question whatever of the blower being able to carry at least 50 per cent overload, but Mr. ——— thinks that the handling of the boilers and the human element in your boiler plant should be taken into consideration and therefore we are making you this guarantee of 30 per cent overload, being convinced, however, that we will show you a 50 per cent increase.

"We will guarantee further that this blower will not take over 1½ per cent of the steam generated by the boiler to operate. We can ship the first blower immediately and if it proves satisfactory can ship five more blowers for your other boilers within two weeks.

"The price of these blowers will be $200 each if satisfactory. A balanced valve will be included with the order to be set in the steam line and connected with the damper regulator to control the blowers automatically.

"A very large saving could be made in your plant with the blowers through the use of buckwheat coal mixed with soft coal, a mixture of 50 per cent each.

"The writer will come down with the first blower to assist in every possible way in taking the test and later with the other blowers to insure their proper installation and operation. According to the figures received, you are burning about 20 lb. of coal per foot of grate surface. We could increase this 50 per cent without trouble, using a blower.

"If after a test on the first blower you decide to equip your entire plant, we will allow 30 days' additional trial in which you may determine the results obtained in the whole battery.

"Trusting that we may be given the opportunity to demonstrate the merits of our machine, we remain,

"Yours very truly,

"——— ——— ———."

A very few words will now suffice to sum up and bring this case to a close.

The foregoing report and proposal were submitted to the heads of the plant organization. A great deal of opposition and argument was met with, the principal objection being the damaging effect forced draft would have on the boilers. Finally, it was voted to install forced draft as recommended by the writer.

For certain reasons, a motor driven fan with ducts to each boiler was decided upon instead of the individual blowers. The entire job occupied about four weeks and cost about $1700. Readers may compare this sum with that of the cost for a new boiler and stack as mentioned earlier in this article.

I never found time to run a complete evaporative test on the plant after the forced draft installation, but will give a few results as furnished to me recently by the engineer at the plant.

They are running only five boilers at this plant now and are very easily carrying a larger load than ever. Careful inspection and continued watching of the boilers show no harmful effects from forced draft. On the average, they are using a coal mixture, costing $363 per day of 24 hr. This represents a saving of $17 a day, or $6000 a year over the cost of coal *before* the installation of forced draft. Labor troubles in the fire room are lessened, as the men do not have to work so hard to maintain the pressure. They still have ample reserve for future requirements, as one boiler is always out for cleaning and repairs and the blower is not being run at maximum capacity yet. Sunday shutdowns, as far as the boiler house is concerned, are a thing of the past and the engineer can take a Sunday off.

In concluding, I wish to explain that I have included my report, etc., verbatim in order to give the reader a clear idea of the method by which the problem was handled. The report was made as complete as possible and figures to back it up were introduced whenever they were available. In this way, a quick decision as to a line of action to be taken was obtainable from the powers that be.

This case differs materially from case one in that the root of the trouble here lay in one thing, a poorly designed type of boiler; while in case one, the troubles were numerous and were found at different points.

Case three will deal with a similar problem which was handled in an entirely different way.

Note—If any of the prices mentioned in these cases seem very large, it must be remembered that these are all Eastern plants and that my work in them was during the years of 1916 and 1917—in other words, during war time.

FROM THE Bureau of Foreign and Domestic Commerce, Washington, D. C., comes the report that a man in Spain wishes to receive catalogs from American manufacturers of electrical and mechanical machinery and material of all kinds, as well as material for lighting vessels. Correspondence should be in Spanish. In writing the Bureau, refer to opportunity 27,334.

A man in Canada wishes to purchase small electric motors, both direct and alternating current. Terms of payment to be arranged. Refer to opportunity 27,336.

REINFORCED CONCRETE for building walls is commonly mixed quite wet and is usually compacted by spading it. Concrete containing less water, and of a quaky rather than fluid consistence, is sometimes specified; but it cannot be tamped economically in thin reinforced walls. However, it can be compacted by striking the forms and the reinforcing bars with a light wooden maul. This suggests the possibility of using a pneumatic hammer for this purpose, for a large number of sharp light raps should be effective in causing the concrete to settle in the forms.—COMPRESSED AIR MAGAZINE.

Coal Storage Systems for Power Plants

DESCRIPTIONS OF GENERAL METHODS OF STORING AND RECLAIMING COAL

STORAGE of coal for power plant use is a special problem at almost every plant. There are, however, a few general systems in use which should be considered for the reason that machinery for these systems has been developed to a high degree of efficiency and reduces hand labor to a minimum.

FIG. 1. COAL IS HANDLED IN THE 225,000-T. STORAGE YARD OF THE NEW YORK EDISON CO., SHADYSIDE, N. J., BY A CABLE RAILWAY AND DISTRIBUTED AND RECLAIMED BY TWO 100-FT. RADIUS LOCOMOTIVE CRANES

Among the points to be considered in making a selection of a storage system, Professor Stoek gives the following:

1. The location, size and topography of the available storage ground.

FIG. 3. VIEW OF STORAGE BINS AND CRANE AT NEBRASKA POWER CO.'S PLANT

2. The capacity of the desired installation; that is, the amount of coal that can be loaded and unloaded in a given time.
3. The cost of the necessary plant.
4. The cost of maintenance.
5. Cost of operation.
6. The amount of breakage due to handling of the coal.
7. Way in which coal is received, in open cars or box cars, or in boats. If coal is received in box cars, buckets cannot be used for loading and unloading.
8. Length of time coal must be kept in storage.
9. Climate. In a cold climate under water storage is impracticable for most of the year.

The requirements of an ideal plant, he states, are:

(1) Adequate ground area, so that several sizes and varieties of coal can be kept separate in storage.

(2) Adequate facilities for rapidly and economically transferring coal from cars or boats into storage.

(3) Adequate facilities for rapidly and economically reclaiming the coal and for rapidly moving any part of the pile that shows evidence of taking fire.

(4) Adequate track facilities for bringing coal to and taking it away from storage with gravity facilities for handling cars, if possible.

(5) Minimum breakage in handling.

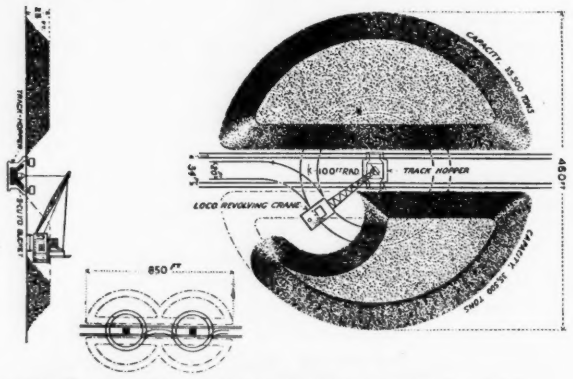


FIG. 2. TYPICAL PLAN OF CIRCULAR STORAGE SYSTEM

(6) Facilities for rescreening the stored coal. This, of course, increases the cost.

(7) Adequate water supply nearby.

(8) Low cost of installation, maintenance and operation per ton of capacity. A storage plant is in operation very irregularly and costs are apt to be correspondingly higher due to the heavy fixed charges, such as interest and depreciation.

These ideals can be modified somewhat in the case of power plants, for some of the conditions stated are not required. For instance, coal used in any one power plant is usually all one size, so that space for keeping different sizes separated is unnecessary. Inasmuch as screenings form the bulk of power plant coal these days, care in preventing the breakage of coal during the reclaiming process has little value; rescreening is also unnecessary for power plant use, but in addition to the above requirements for an ideal system, we would add a coal crusher, which will enable the plant to store lump coal and reduce it to a usable size after it has been reclaimed.

Storage Systems

The most common system about small power plants is that of hand storage, which consists of dumping or shoveling coal from cars onto the ground, into bins, bunkers, storage room or to the floors of the boiler room. Where considerable area is covered, scrapers, wheelbarrows or industrial cars are used to spread or reclaim the coal.

During recent years, the motor truck has become quite universally used for hauling coal from cars to distant plants and for storing coal, particularly screenings, in open spaces such trucks are convenient. By this means the coal may be dumped in layers one on top of another, the truck traveling on planks laid on the surface of the first layer while storing the second, packs the coal closely, thus closing up air pockets and preventing the formation of crevices which are an aid to spontaneous combustion. At the University of Illinois satisfactory results have been obtained by this method of storing screenings in piles 10 to 12 ft. deep. Reclaiming may be done by means of wheelbarrows, industrial cars or scrapers.

For both storing and reclaiming coal, the mast and gaff device is simple, economical and inexpensive. When fitted with an extension in the form of a traveling cableway, the area covered can be increased, making the system well adapted to power plants of medium size.

Where the topography of the location will permit, trestle storage has many advantages. This consists of dumping coal from railway cars run upon a trestle into open piles or bins. To use such a system to advantage, coal should come to the plant in drop bottom cars, as unloading by hand is expensive. To reclaim the coal, wheelbarrows, steam shovels or locomotive cranes are employed. When stored in bins, however, the coal may be delivered by gravity to industrial cars or the conveying system of the plant.

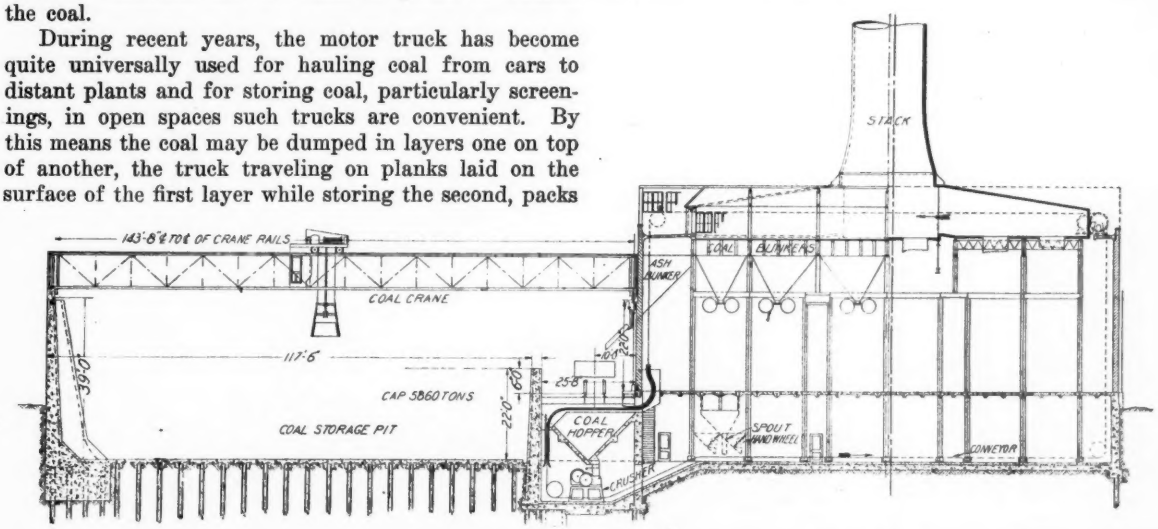


FIG. 4. ELEVATION SHOWING SCHEME OF COAL HANDLING SYSTEM AT THE NEBRASKA POWER CO.'S PLANT

Storing and reclaiming coal by means of a locomotive crane equipped with some form of grab bucket is the system most commonly employed by power plants of the larger size. In this system, the storage yard has a number of railroad tracks running the full length parallel to each other at such a distance apart that the crane will have access to the entire area. When space between tracks is not sufficient, the tracks themselves may be covered, which increases greatly the capacity for storage. By special arrangements of the tracks, the locomotive crane system is well adapted to storage in circular or oblong areas.

Where large quantities of coal are used, a common method of handling is by means of a steel bridge which runs over the storage area and is equipped with a grab

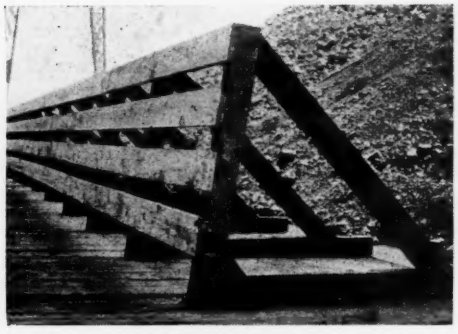


FIG. 5. SELF-ANCHORED FRAMEWORK BARRIER FOR COAL PILES

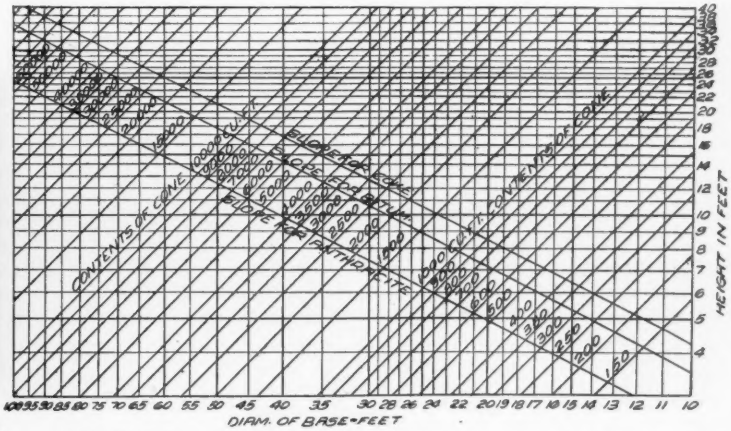


FIG. 6. CHART FOR ESTIMATING VOLUME OF A PILE OF COAL IN THE SHAPE OF A CONE

bucket. Both ends of the bridge may be movable or only one, and this device is suitable for both storing and reclaiming the coal.

In recent years, under water storage has been employed at a number of power plants, the method being applied to screenings due to the danger of spontaneous combustion in stored coal of this grade. This method is applicable in climates where the temperature remains above freezing, or during the warmer season of the year, but when freezing occurs there is difficulty in reclaiming the coal.

Under Water Storage at Omaha

Among recently built under water coal storage pits are those of the Nebraska Power Co., at Omaha. Difficulty experienced in storing the bituminous screenings, which are used as fuel, led to the construction of two reinforced concrete pits adjacent to the power plant. Each of these is 115 ft. wide by 120 ft. long by 22 ft. deep, with a total capacity of 12,000 t.

Coal, which at present consists of Kirkville, Mo., or Cherokee, Kan., screenings, is delivered to the plant by rail, the tracks being laid between the coal bins and the power house. From the cars, coal may be delivered directly to the bucket-conveying system, or by means of a traveling crane and clam shell grab bucket, it may be delivered to the storage bins.

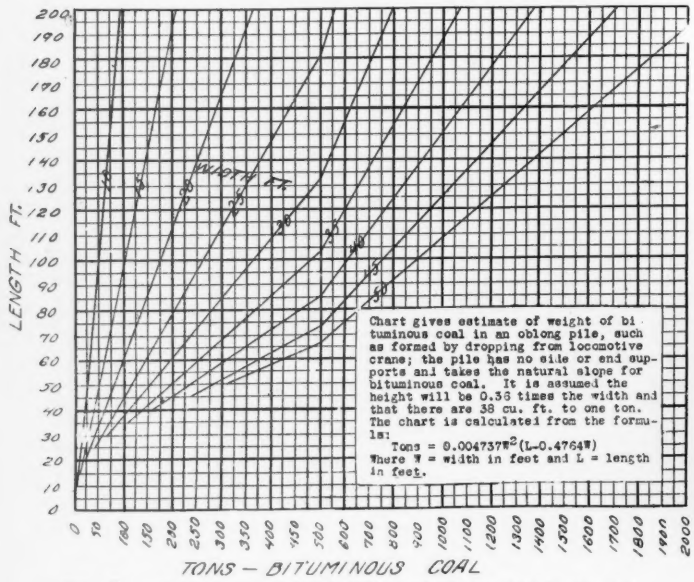

LENGTH FT.
WIDTH FT.
TONS — BITUMINOUS COAL
Chart gives estimate of weight of bituminous coal in an oblong pile, such as formed by dropping from locomotive crane; the pile has no side or end supports and takes the natural slope for bituminous coal. It is assumed the height will be 0.36 times the width and that there are 38 cu. ft. to one ton. The chart is calculated from the formula:
Tons = 0.004737W²(L-0.4764W)
Where W = width in feet and L = length in feet.

FIG. 7. CHART FOR ESTIMATING TONS OF COAL IN AN OBLONG PILE

Water pumped directly from the Missouri River on the opposite side of the power plant is used for keeping the coal flooded. At the time the accompanying photograph was taken, however, the bins contained considerably more coal than their normal capacity, and as a consequence it was found necessary to watch the temperature of that coal above water level very carefully to prevent firing. Each day a pipe is driven into the pile and after 24 hr. a thermometer is lowered into the pipe and temperature is read. A systematic method of taking these readings about 10 ft. apart is carried out, and if the temperature in any section reaches 180 deg. F., the coal affected is used in the furnaces as rapidly as needed. Or, should steam be noticed coming from any section of the coal pile, the clam shell bucket is used to dig out the coal and deliver it to the bucket conveyor. Aside from these diversions to prevent firing in the pile above water level, the coal is used systematically from the storage, the plan being to use that longest in storage.

Reinforced Concrete Coal Pockets

Using principles learned in the construction of grain elevators, a reinforced concrete coal storage system has been designed by the Macdonald Engineering Co. for F. W. Stock & Sons, which has proved, during the year it has been in operation, the feasibility of storing bituminous screenings without danger of spontaneous combustion.

Two bins of cylindrical form with the axes vertical are tied together with reinforced concrete construction. A bucket elevator is installed in the irregular spaces between the bins which is driven by a 15-hp. motor and elevates the coal from a receiving pit to the top of either bin. Its capacity is about one carload an hour.

FIG. 8. VIEW OF REINFORCED CONCRETE STORAGE BINS

Ordinarily the coal used at this plant is slack, but a crusher is provided for reducing lump coal to a size that can be handled in the elevator buckets.

The bins have a combined capacity of 2000 t. each, having a diameter of approximately 28 ft. and a height of 70 ft. The cost of the entire equipment in round numbers is $10 per ton of storage capacity, and the cost of handling the coal, which includes depreciation and interest on investment, has been $0.03 per ton from the railway car to the boiler.

Beneath the bins is an industrial track leading to the boiler room. The hand-pushed coal cars are loaded by passing the coal through gates, three of which are located at the bottom of each bin. The walls are water tight and each bin has a spray pipe at the top through which the entire contents may be flooded in case a fire should start.

Slack coal put into one of these bins remained untouched for nearly one year, at which time it was run out, and its temperature at any point did not exceed 120 deg. F. The other bin has been used continuously; coal delivered at the top and taken from the bottom has at no time shown indications of heating.

TABLE I. CAPACITY OF CIRCULAR CRANE STORAGE

(Link-Belt Company)

Radius of Crane (Feet)	Crane Tracks Covered (Feet)						
	10	15	20	25	30	35	40
35	.....	.....	7,000	.....	.....	.....	.....
40	.....	.....	9,600	12,400	.....	.....	.....
45	.....	.....	11,500	16,000	.....	.....	.....
50	.....	.....	15,000	19,500	25,300	.....	.....
55	.....	.....	17,600	24,000	29,200	.....	.....
60	.....	.....	22,700	28,500	35,400	42,100	.....
65	.....	.....	25,600	32,800	39,100	46,900	.....
70	.....	.....	30,500	39,100	46,300	54,300	.....
75	.....	.....	32,600	44,300	55,600	63,800	.....
80	.....	.....	39,440	49,700	60,800	69,600	82,200
85	.....	.....	43,600	56,100	68,300	82,300	94,400
90	.....	34,500	46,300	58,100	70,100	84,250	96,200
95	.....	39,130	53,220	66,540	78,800	92,300	106,300
100	.....	43,500	57,700	74,000	89,300	103,900	122,000
110	.....	53,500	71,300	89,000	107,700	123,800	142,300
Radius of Crane (Feet)	**Crane Tracks Uncovered (Feet)**						
	10	15	20	25	30	35	40
35	.....	.....	6,050	.....	.....	.....	.....
40	.....	.....	6,850	8,875	.....	.....	.....
45	.....	.....	9,280	11,720	.....	.....	.....
50	.....	.....	11,200	14,000	17,600	.....	.....
55	.....	.....	13,500	17,100	21,000	.....	.....
60	.....	.....	15,900	20,400	25,100	29,600	.....
65	.....	.....	19,400	23,700	29,100	34,500	.....
70	.....	.....	22,300	29,600	34,200	39,300	.....
75	.....	.....	25,300	30,800	39,500	45,800	.....
80	.....	.....	30,100	37,600	45,200	53,600	61,500
85	.....	.....	34,400	41,900	50,700	60,500	71,100
90	.....	31,200	41,500	52,100	60,800	70,800	80,600
95	.....	32,900	43,800	54,500	63,000	72,100	82,500
100	.....	36,200	47,000	60,000	69,000	79,100	90,600
110	.....	45,500	60,100	74,000	85,000	94,800	106,500

This system presents several features which make it unusually attractive for power plants. The bins, being vertical, occupy the least amount of ground space for their capacity. Inasmuch as the coal is taken from the bottom of the bin, all fuel used remains in storage about the same length of time, so that the burning quality remains practically constant and the tempering of the coal need not be varied, as when ground storage is employed. This process of drawing from the bottom also insures a uniform size, as the finer particles do not get a chance to separate from the larger lumps of coal. So far as the nature of spontaneous combustion is understood, this system of storage will prevent its occurrence to any extent, due to the elimination of air circulation, but even should a fire start, it can readily be extinguished by flooding the bin with water. If parts of the coal should become overheated, the bin may be emptied and the coal elevated back up into the bin, the heated coal shunted to one side and used immediately or allowed to cool before returning it to the bin. This can all be done mechanically and at little expense.

TABLE II. WEIGHT OF COAL IN PILES OR STORAGE SPACE—TONS

Volume	Anthracite		Bituminous or Lignite		Peat or Turf		Charcoal		Coke	
Cu. Ft.	Loose	Settled	Loose	Settled	Loose	Settled	Loose	Settled	Loose	Settled
1	47 lb.	58 lb.	40 lb.	54 lb.	20 lb.	26 lb.	10 lb.	14 lb.	23 lb.	32 lb.
50	1.18	1.45	1.0	1.35	0.5	0.65	0.25	0.35	0.60	0.8
100	2.35	2.9	2.0	2.7	1.0	1.3	0.5	0.7	1.15	1.6
150	3.53	4.35	3.0	4.05	1.5	1.95	0.75	1.05	1.73	2.4
200	4.7	5.8	4.0	5.4	2.0	2.6	1.0	1.4	2.3	3.2
250	5.88	7.25	5.0	6.75	2.5	3.25	1.25	1.75	2.88	4.0
300	7.05	8.7	6.0	8.1	3.0	3.9	1.5	2.1	3.45	4.8
350	8.23	10.15	7.0	9.45	3.5	4.55	1.75	2.45	4.03	5.6
400	9.4	11.6	8.0	10.8	4.0	5.2	2.0	2.8	4.6	6.4
450	10.58	13.05	9.0	12.15	4.5	5.85	2.25	3.15	5.18	7.2
500	11.75	14.5	10.0	13.5	5.0	6.5	2.5	3.5	5 75	8.0
550	12.93	15.95	11.0	14.85	5.5	7.15	2.75	3.85	6.35	8.8
600	14.1	17.4	12.0	16.2	6.0	7.8	3.0	4.2	6.9	9.6
650	15.28	18.85	13.0	17.55	6.5	8.45	3.25	4.55	7.48	10.4
700	16.45	20.3	14.0	18.9	7.0	9.1	3.5	4.9	8.06	11.2
750	17.63	21.75	15.0	20.25	7.5	9.75	3.75	5.25	8.65	12.0
800	18.8	23.2	16.0	21.6	8.0	10.4	4.0	5.6	9.2	12.8
850	19.98	24.65	17.0	22.95	8.5	11.05	4.25	5.95	9.78	13.6
900	21.16	26.1	18.0	24.3	9.0	11.7	4.50	6.3	10.36	14.4
950	22.34	27.55	19.0	25.65	9.5	12.35	4.75	6.65	10.94	15.2
1000	23.5	29.0	20.0	27.0	10.0	13.0	5.0	7.0	11.5	16.0

The weight of greater volumes may easily be determined to the nearest 50 cu. ft. by multiplying the above values by multiples of 10 and adding, thus: The weight of 53,250 cu. ft. of settled bituminous is 13.5 x 100 plus 8.1 x 10 plus 5.75 = 1457.5 tons.

How to Increase Artesian Well Supplies

By Frank Bohl

DURING my experience in operating artesian wells, I have found that the best results are obtained by running a well steady. Stopping and starting a well causes the veins to close.

To make a well better, you must force the water to the lowest point, in order to make the water in the ground under the well the weakest point, so that the water will flow faster to the weakest and lowest point; this is the way to open new veins and reach out farther in the ground for water.

You may use any kind of system for pumping, but the air lift is the most economical way of operating a deep well.

The well may pump down very low. We should not be worried about that, however, because they will do this before they will improve. This is particularly true if you have been stopping and starting your wells.

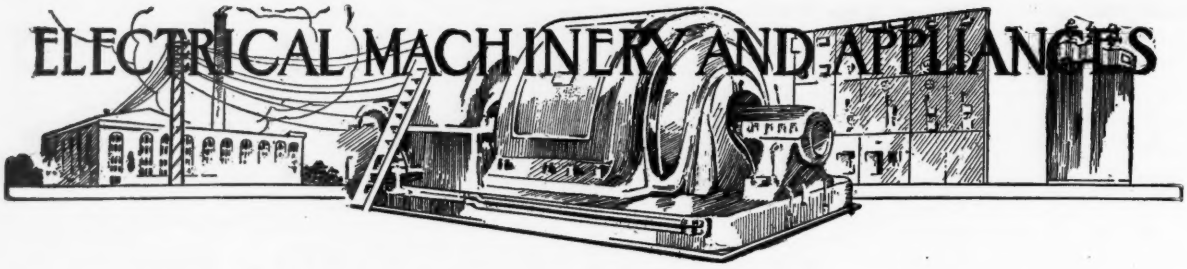
Do not expect to see results in one month or six months; it may take steady pumping for a year. You will surely obtain results if only slowly.

If you are pumping with air lift, be careful not to give the well too much air; that might cause what we call slippage of air, which may be recognized by the appearance of exceedingly large bubbles.

Efficient air-lift pumping is not how much pressure you can get in the well, but the smallest amount of air that will cause the water to rise to the top with a steady flow.

The air must be thoroughly mixed with the water so as to lighten the column with small bubbles or a milky looking water; this will cause gravity to force the lower water in the well and will result in a steady flow.

The city council of Birmingham, England, has approved the project for a large expenditure in electric supply equipment. A permanent generating station is to be constructed at Nechells, at an estimated cost for building and equipment of $6,500,000, to have capacity of 30,000 kw. The mains and substation equipment are estimated to cost $1,400,000. Previous to the beginning of the war, the construction and equipment of a station at Nechells had been authorized, to cost $1,360,000, but this station was not completed, and a temporary station was sanctioned in 1915. This was insufficient, and additional plant since provided has been found inadequate, so that the present authorization has been made as an emergency measure



Cross Connection of Reverse-Power Relays

WHILE in general transmission and distribution systems can readily be sectionalized by the standard application of overload and reverse-power relays, there are often conditions under which these methods do not suffice. Some of these can be handled readily by a balanced system of relays, two methods of which, the pilot wire system and the split conductor system, have been in use for some time. These, however, to any extent, due to the elimination of air circulation, have their disadvantages, among which are the expense of the additional cables necessary and, in the split-conductor system, the possibility of trouble occurring on both conductors simultaneously, in which case the relays would not clear the trouble.

A later method of balancing relays on parallel feeders, and not having the above disadvantages, is the cross-connection of reverse-power relays.

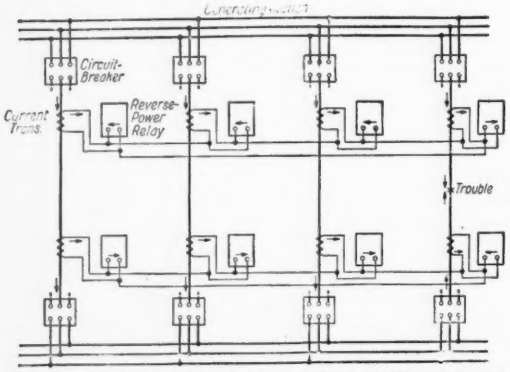


FIG. 1. SCHEMATIC DIAGRAM OF CROSS-CONNECTED RELAY SYSTEM

The schematic diagram of Fig. 1 shows the connections of cross-connected reverse-power relays applied to a system consisting of a generating station and a substation connected by four parallel feeders. For the sake of simplicity the diagram shows one phase only of each of the feeders. A complete diagram of connections for a pair of three-phase feeders (except that the tripping circuit is omitted) is shown in Fig. 2.

By reference to both Figs. 1 and 2, it will be seen that all the current transformers in the generating station are connected in series; likewise, those in the substation; and that each relay, which must be a reverse-power (unidirectional) relay, is shunted across its current transformer.

It should be borne in mind that, while shown in Figs. 1 and 2 for a particular, and comparatively simple, condition, this scheme can be used with equal success in any part of a complicated network. While preferably the cables in the parallel system should be alike, if there is a difference in their impedance this difference can be compensated for by simple means.

Under normal conditions the load in each of the cables will be the same and, since the relays have a higher impedance than the current transformers, the current from the latter will therefore circulate through all of them in series without any flowing through the relays. If trouble occurs at any point outside the section protected by these cross-connected relays, the current through the cables will still be balanced, and, consequently, there is no force tending to operate the relays. On the other hand, if trouble occurs on a cable

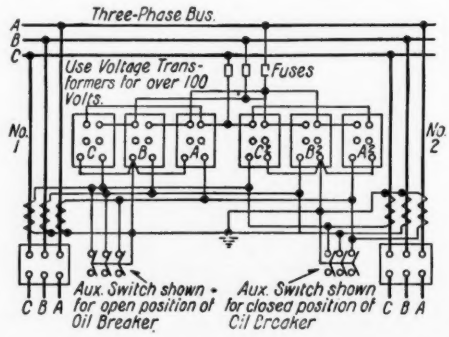


FIG. 2. DIAGRAM OF CROSS-CONNECTED RELAY SYSTEM—CONNECTIONS FOR 3-PHASE CIRCUIT COMPLETE EXCEPT FOR TRIP CIRCUIT

within the section, the current through the defective cable will be higher than that in the others, and the excess current from its current transformers must, therefore, pass through the relays. While under this unbalanced condition current will flow through all the relays, it will be observed that the current is in the proper direction to cause the relay to act only in the relays at each end of the defective cables (see direction of arrows in diagram).

In Fig. 2 are shown pallet switches connected in the transformer secondary circuit. These are, also, connected mechanically to the operating mechanism of the breaker, so that when the breaker opens the current transformers on the feeder controlled will be short-circuited. By this method a cable can be cut out of service without interfering with the electrical balance in the current-transformer circuit.

It will be noticed by reference to Fig. 1 that when

the cross-connected scheme is used on only two cables, the two sets of relays are actually in parallel, and are arranged to operate in the opposite directions. The expense of the two-cable cross-connected system can be reduced by using, in place of the two sets of reverse-power relays, one set of special relays having two contacts, one to close when power flows in one direction, and the other in the reverse direction, see Fig. 3.

Among the advantages of the cross-connected system of reverse-power relays are:

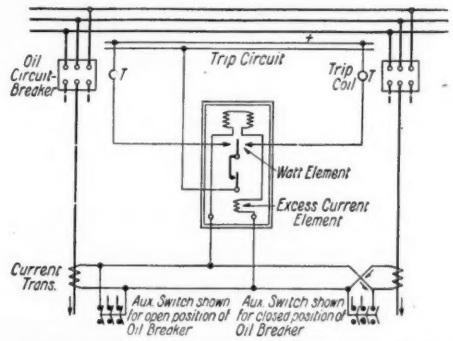


FIG. 3. DOUBLE CONTACT WESTINGHOUSE TYPE CR REVERSE POWER RELAY APPLIED TO DUPLICATE FEEDERS—CONNECTIONS SHOWN FOR ONE PHASE

1. It may be applied to any system, no matter how complex, if the feeders are run in parallel between the switching points.

2. It is practically instantaneous in operation.

3. It can be set to operate on smaller currents than the full-load current of each feeder. This enables the clearing of trouble on a system having the neutral grounded through such high resistance that the total

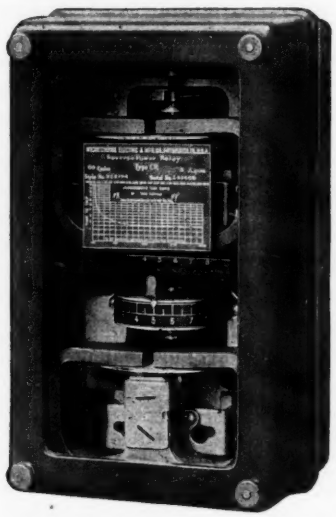


FIG. 4. WESTINGHOUSE TYPE CR RELAY

trouble and load current flowing through a single cable may be less than the maximum-load current of that cable.

4. It does not require change of adjustments each time generating stations are cut in or out of service.

5. It is more economical than the split conductor, or the pilot wire system, not requiring so much cable.

6. To avoid the condition arising from trouble occurring at the same time on both conductors of a split-conductor cable, a modified split-conductor scheme, using standard cables but operating them in pairs and disconnecting both in case of trouble on either one, has been tried. Cross-connected reverse-power relays are superior to this method of balancing because they cut out only the bad feeder.

Pointers on Storage Battery Operation

By T. H. Reardon

BEING directly connected with the charging and care of storage batteries, the writer has had occasion several times to seek information from either a local chemical laboratory, or from the manufacturers in regard to certain peculiarities which though interesting and even important are not explained in manufacturer's pamphlets nor in the literature of the storage battery. Take, for instance, the statement that in a lead battery the charging voltage will attain a value of 2.5 v. per cell at the end of a complete charge. This statement needs qualification. The charging e.m.f. at any instant is equal to the counter e.m.f. of the storage battery plus the e.m.f. necessary to overcome the internal or ohmic resistance of the battery.

A battery may be charged while its temperature is anywhere between 40 and 100 deg. F. The resistance of the electrolyte falls rapidly as the temperature rises and the voltage necessary to overcome internal resistance is correspondingly reduced so the fact that the final charging voltage does not rise to a specified figure cannot be construed to mean that the battery is undercharged or that it is incapable of rising to the specified voltage provided the temperature was lower. This condition holds in both lead and alkaline batteries.

Another matter that confuses people other than professional battery men resides in the fact that the specific gravity may fail to reach the proper value when all other indications show that the battery is completely charged. The electrolyte may be too weak, in which case it will not come up anyway; that is, if the solution is maintained at the proper height in the cells. If the electrolyte is too dense, the specific gravity may reach the high mark when the cell is only half charged. Specific gravity readings unless intelligently taken are absolutely worthless. Temperature makes a great amount of difference and its effect is often overlooked.

In a battery using dilute sulphuric acid for electrolyte, add one point to the hydrometer reading for each 3 deg. above 60 deg. F. Below 60 deg. F. subtract in the same way.

If the manufacturer specifies 70 deg. F. as standard. use that figure for a base; all manufacturers do not have the same standard figure. For a caustic soda electrolyte which is used in the Edison storage battery at the present time, add one point for each 5 deg. above 60 deg. F., subtracting when working below 60 deg. Never take the hydrometer reading after adding water to either the lead or alkaline storage battery, until the electrolyte has been thoroughly agitated by charging. The acid electro-

lyte undergoes an electrochemical change in addition to the agitation that is produced by gassing which is equivalent to mechanical agitation.

The charging of the alkaline battery has no electrochemical effect on the electrolyte, the higher specific gravity observed after charging (when water has been previously added), is due simply and solely to the thorough admixture of the electrolyte by the gas passing upward through it and creating a circulation.

The writer has taken hydrometer readings in Edison storage batteries immediately after adding a large amount of water to replenish loss by evaporation, and the sp. gr. which normally was 1.160 was read as low as 1.02. Even after standing 3 or 4 hr., the density would come up scarcely at all, but after charging it would come back to normal. The explanation is simple. The added water hangs in a stratum on top and it is really surprising how long it remains without admixing.

In this latter connection, the writer has had some queer experiences. He has been using a patent filler so arranged that the electrolyte when at the proper level would close a bell circuit and ring a bell. Water got unusually low in some hardworked batteries and the water commenced to "go over the top," the bell remaining silent. It was discovered that the addition of an excessive amount of water weakened the upper strata of the electrolyte to such an extent that its resistance became so high that the bell would not ring; *i.e.*, the batteries could not force enough current through to ring the bell. This was overcome by putting a relay on the water pail, the relay circuit being through the weak electrolyte with the bell in a second circuit and this circuit was closed by the relay. By adjusting the relay carefully, it will close the bell circuit, the bell ringing vigorously with full battery power. Even with this arrangement, if the solution in a battery gets abnormally low, requiring an excessive amount of water at one time, the relay will fail to operate and the cup and funnel has to be used as a last resort.

When watering once a week will not take care of batteries properly, watering twice a week is the only remedy.

In changing from once a week to twice a week, the writer has noticed that the total amount of water required per battery per week when added in two installments is only about half the amount required if the battery is allowed to run a full week and get the entire amount at the end of the week. Once the solution gets below the top of the battery plates, it falls rapidly.

A LITTLE while ago, it took 2 yr. to build a fast destroyer. Now one has been built in a little over 2 mo. On the first attempt at speeding up, one was built in 8 mo. The next step was one in 6 mo. Now 2 mo. has been reached, and by a method that makes it possible to do it over and over again, and in quantities. The navy reports that one flotilla of destroyers has steamed a million miles on patrol, has protected 86 convoys and 717 single vessels, has fought 81 submarines and no loss to the destroyers or to the vessels convoyed.

HELP your Government and yourself at the same time—buy War Savings Stamps.

A Fair Deal on the Job

IF you were a workman in Italy or Slavonia or Esthonia or some other European place, you wouldn't like to be called out of your name. If your name is Jones you'd rather be called Jones than Hunkie or Wop or Yank, or Square Head, or Dago—or something else. Think it over!

2. If you were a workman in Italy or in Slavonia or Esthonia or some other European place, you wouldn't like to have a workman jeer because you carried apple pie in your dinner pail. Because you don't eat garlic, don't think the man who does so is necessarily a murderer; your pie may be in as bad odor with him, as his garlic is with you.

3. If you worked in Italy or Slavonia or Esthonia or some other European place, you might not understand what the boss was saying to you when he told you to get out of the way. If the man ahead or behind you doesn't understand, take a little time and help the foreman to put his meaning across to him, and during the noon hour teach the foreigner the few words of "get out of the way," in English.

4. If you worked in Italy or Slavonia or Esthonia or some other European place, you might find a time clock, the mechanism of which you didn't understand; if the fellow just ahead or behind you doesn't understand, show him—it won't hurt you and you'll feel as good as he will over the action.

5. If you worked in Italy or Slavonia or Esthonia or some other European place, you'd feel kindly toward the man who butted in to help you, either on your job or with a strange language, or to understand who's who in the shop. Don't forget it when the man behind or in front of you looks bewildered.

6. If you worked in Italy or Esthonia or Slavonia or some other place in Europe, you'd find that the one thing you and your fellow workmen quickly acquired in common was an oath. Same here! Make it a laugh instead!

7. If you worked in Italy or Slavonia or Esthonia or some other European place, you'd be lonesome if you didn't know anything of what the man ahead of you was thinking about, once in a while; bear that in mind; put yourself in his place; language was made to express thought; think right and tell the man beside you.

8. If you worked in Italy or Slavonia or Esthonia or some other European place, and your boy or girl fell ill and the next door neighbor came in with a hot water bottle you'd begin to cheer up. The fellow next you feels the same way about life; a man's boys and girls are the same to their fathers and mothers the world over.

9. If you worked in Italy or Slavonia or Esthonia or some other place in Europe, you'd feel more happy if you saw your lonesome wife treated as a friend by the cheerful wife of the fellow next door. Mention this to your wife. She'll do her bit.

10. If you worked in Italy or Slavonia or Esthonia, maybe the man ahead or behind you wouldn't like your looks because he wouldn't be used to them. That would be hard on you. Think it over! You can't tell by the looks of a toad how far he'll jump—and think that over.

Factory Chimney Repairs

By Mark Meredith

ON ACCOUNT of an ingenious arrangement adapted for repairing a brick chimney 163 ft. in height at a colliery in East India, where no steeplejacks were available, has been recorded by T. H. Ward.

Necessary repairs were excessive, and included the pointing of several serious cracks and the clamping of the chimney from top to bottom. The essential points of the plan adopted were (1) a scaffold which would automatically adjust itself to the varying diameter of the chimney when going up or coming down, and (2) points of support, on the chimney itself, at an accessible distance above one another, from which the scaffold could be suspended, and raised or lowered. The automatic adjustment of the scaffold was provided for by making it of galvanized iron gas pipes in eight corner sections (the chimney was octagonal), the sections being built of 2-in. and 1½-in. pipe alternately, and the whole put together to make the complete octagonal scaffold by sliding the ends of the smaller pipes into the larger. The framework of the fence and the deck was thus collapsible or extensible, and could adjust itself to the varying diameter of the chimney; the deck itself was laid of light 12-in. plank secured adjustably to the pipes. The clamping of the chimney consisted of 1-in. diameter tie-rods, which passed through castings fixed 3 in. deep in the brickwork at each corner, so that when fixed the tie-rods were practically flush with the face of the brickwork, and it was by means of these castings which would, of course, carry a heavy vertical load that the scaffold was secured, raised or lowered.

The work was begun at the bottom of the chimney. The first clamp was put in place at a convenient height, and permanently tightened up. Each casting was provided at the top with a pair of ears bored to take the pin of a two-sheave pulley block. The blocks were put in place and the scaffold pulled up nearly to the level of the clamp, where it was secured for the time being by hooking short chains on the other lugs provided at the bottom of the corner castings. The next range of clamps was now fixed, and the raising operation repeated stage by stage until the top was reached. The batter of the chimney, 1 in 40, kept the eight sections of the scaffold close to the chimney under gravity. In raising or lowering the scaffold eight men, sitting on the scaffold, one at each corner, were required to fend off, so that the projecting ears of the corner castings could be safely negotiated. The scaffold could, it was found, be raised into position for a new ring and made fast in about 15 min.

The whole undertaking appears to have been remarkably successful, and Mr. Ward ventures the suggestion that as a chimney must sooner or later require repairs by far the best plan is to clamp it when it is being built. This plan would generally prevent the formation of serious cracks and as a system of clamping on the lines described above could be adopted, the advantage of clamping the chimney as it is being built is that the clamps could be spaced farther apart, since the only operation which would have to be performed from the scaffold in case of subsequent repairs would be the putting in, or taking out, of the pins supporting the upper pair of wheels of the two sheave blocks. This can be effected at the full stretch of a man's arm, or by standing on something. The suggestion is well worth consideration.

Fourth Liberty Loan

WHEN you subscribe to this loan, you record your conviction that women and children should not be sent to the bottom of the sea, when traveling on unarmed ships; that women, children and old men should not be ravished, maimed and tortured under the plea of military measures; that hospital ships should not be sunk without warning or hospitals bombed. You endorse the doctrine that small nations have the same rights as large ones, and military force shall not be used to secure world dominion.

If this cannot be found, find a piece of cast-iron you are lending the United States enough money to feed a soldier in France for 7 mo.; or to give him a complete outfit of winter and summer clothing. A second $100 will arm him with rifle, bayonet and 1000 cartridges, and a good-sized bomb which will destroy a Hun machine gun or dugout. You have helped to equip him and send him to fight the battle which will save your home and your family from German domination and destruction.

A MISSION composed of French ordnance engineers, technical experts and shop foremen is now in this country for the purpose of studying American methods of manufacture of war material.

The visit of this mission is the result of an agreement between the French Minister of Munitions and the Chief Ordnance Officer of the American Expeditionary Forces, to have such missions from each country visit the other in order to secure the closest co-operation between the two countries in regard to their industrial facilities.

In this manner, it will be possible to standardize certain details of manufacture, to promote the development of new resources and otherwise secure for each country the benefits of the technical improvements made by its ally.

The head of the mission is Lieutenant Colonel Martinon, for several years in charge of manufacturing at the well-known munitions plant of Schneider et Cei. Le Greuset, manufacturer of the 155 mm. howitzer.

The mission will be divided into groups representing the various subjects with which the different members are most familiar. To each group will be assigned ordnance officers who are also experts on these subjects.

These groups will then visit the principal arsenals and private plants engaged in the manufacture of war materials, and will not only consider the engineering features, but production and inspection as well, where the particular projects are far enough advanced to permit it.

All communications relative to the activities of the mission should be addressed to Secretary, Franco-American Ordnance Committee, Army-Navy Bldgs., Group B, Room H 215, Washington, D. C.

WHEN you buy War Savings Stamps you do not give—you receive.

Rebabbiting a Thrust Bearing

By Babbit

PROVIDED one is fairly skilful with a lathe and scrapers there is no difficulty in re-lining a bearing, although the job depends to some extent on experience.

I have known some men make a fair job by using the shafts and bearings in place heated up to cast their linings, but the method is bad; it is far better, particularly when working with a thrust bearing, to take the necessary time in making up jigs and a mandrel and working under better conditions. Following on these lines, a few days before it is decided to do the job, take down the bearing and get exact measurements, diameter of shaft, diameter of rings, width of rings, distance each is apart, length of bearing shell, outside diameter. The machine can then be put to work again, while preparatory work is done. First make the jigs, two sheets of steel or wrought-iron about ⅛ in. thick, and about 2 in. larger in both directions than the face of the bearing shell, file up true, chuck both together in a four-jaw chuck and bore a hole out of the center so that there is exactly half the circle in each plate, the hole being exactly the same diameter as the shaft at the end of the bearing. Now drill three ½-in. or ⅝-in. holes, two near the top and one below the center, and fit bolts, so that the plates can grip the bearing shell, as shown in Fig. 1.

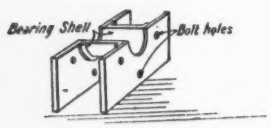


Fig. 1.

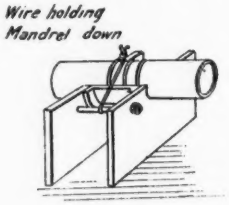


Fig. 2.

FIG. 1. BEARING SHELL IN JIGS
FIG. 2. MANDREL IN PLACE READY FOR POURING

Now prepare the mandrel; this is best made of a thin steel tube with an outside diameter about 1/64 in. smaller than the diameter of the shaft.

If this cannot be found, find a piece of cast-iron pipe and turn down in the lathe to size; emery up, and finally polish with dry graphite. Turn up some cast-iron rings same diameter as thrust collar, same width at the base, but these are best tapered very slightly on both sides to assist in getting them out of the set metal. The rings should be bored to be a tight fit on the mandrel; these rings, pushed on the mandrel and spaced exactly the same as the rings on the shaft, leave the mandrel an exact copy of the shaft, except that it is 1/64 in. smaller in diameter. You now want to prepare heating arrangements; the best outfit would be two gas rings and a bunsen burner. If these are not available, petrol blow lamps can be used, but not paraffin blow lamps. Failing these, I can only suggest a forge burning coke and the kitchen oven with a fierce heat on. This latter would be quite a suitable means of heating the shell jigs, and mandrel, if they are not too large, and the forge for melting the metal.

The preparatory work being completed, you next want the bearing shells thoroughly clean, getting off every trace of oil. Either melt or cut away all the old anti-friction metal; every part of the shell that has to be in contact with the new metal must now be tinned with either pure tin or at least best tinman's solder, using killed spirit as flux. Do not depend on any old tinning, it is not reliable. See whether the new tinning is really adhering, and wipe out any surplus with a clean piece of tow. Now clamp one of the bearing shells between the jigs, using a thin piece of asbestos paper between the faces to prevent leaks, and making certain that the shell is exactly centered. Now lay the mandrel in the half circles, try it with feelers to see that it is in the center of the shell; if so, wire down as shown in Fig. 2, and see that the collars are located just where you want them. Pack up, outside the jig, around the mandrel with a mixture of asbestos and machine or cylinder oil to prevent leaks.

The shell and mandrel should now be heated to about 550 to 600 deg. F., or a temperature that is just below what it takes to make the tinning run. The best way is on a gas ring, with the bunsen burner playing through the hollow mandrel and outside the jig plates, but on no account must the flame reach the tinned surface. While this is going on, melt the metal in a clean ladle over the other ring, using only just enough heat to do the melting, and stir continually. As soon as a piece of white paper can be pushed easily into the melted metal, and it just browns, the metal is hot enough and should be poured as quickly as possible. Properly fill the half bearing so that there will be some to file or cut off, and allow for shrinkage.

Now cool the bottom of the shell as quickly as possible. A sponge of cold water applied underneath, a cold air blast, or anything to cool the bottom quickly, to ensure that whatever shrinkage there is shall take place before the top of the metal sets, and the molten metal can follow the shrinkage.

When cool enough to work on, get off the jigs and knock the shell gently away from the mandrel; the jig and mandrel are then ready to do duty on the other half, following the same procedure.

All that is now left to do is to scrape to a fit. First scrape out the collar grooves so that they fit properly, and then bed down the main portion of the bearing. As the mandrel was only 1/64 in. smaller in diameter there is only just over 1/130 in. to scrape away all around, but as the metal does not always cool without warping slightly this is not an even scrape all over.

Respecting the metal to be used, it is best to buy a well-known brand that is guaranteed to stand heavy pressures. As the weight of the metal in one bearing is small the saving in first cost in using the lighter grades is insignificant, but as one will see, the cost of re-lining a bearing is mostly made up in labor, and as the heavier tin base metals last much longer, it is a poor policy to use the cheap metals. If the amount of metal required does not warrant getting an ingot of anti-friction metal, you will find good tough metal with excellent wearing properties is made from two parts pure virgin tin to one part pure virgin lead; this wears well and will not damage the shaft, but unless you use virgin metals you cannot be sure that you are not getting injurious adulterations.—The Power User.

Suggestions to the Fuel Administrator

AT A RECENT noon-day meeting of chief engineers of individual power and heating plants located in the business district of Chicago the advantages of block plants were discussed, and as a result the following letter, signed by the chief engineers of the most important plants in this district, was sent to the Cook County Fuel Administrator and the War Industries Board, Regional District No. 9. Coming as it does from men most familiar with the conditions existing in this type of power plant, this suggestion carries great weight and should be given more than ordinary consideration by the Fuel Administration:

Gentlemen:

With the passing of summer and the approach of winter, the fuel question again stands sharply before us.

No body of men in the country is more interested in this question than the men in charge of steam power plants, and few are better qualified to offer practical suggestions of a progressive nature.

From the heart of Chicago the undersigned chief engineers respectfully submit for your consideration a view of power plant operation looking to coal conservation.

In many of the congested mercantile districts are located private steam power plants generating enough power for a given building or factory, and in some cases distributing a portion to some neighboring institution in the form of light, power and heat.

The men employed are skilled in their respective duties, order and discipline prevail, and the result is efficiency.

Other business houses in the immediate vicinity require no power, or purchase what little they need.

In the winter months, the plant generating power uses the exhaust steam from the engines, thereby getting use of the steam again without any additional cost of coal. This plant has a surplus in many cases which escapes to the atmosphere.

In the plant generating steam for heat only, the steam performs but one function. In most cases, the attendant is a janitor or helper of some sort, whose main duties lie along other lines, and care of the heating plant is an added duty.

The result is that in the steam power plant a boiler or furnace efficiency of better than 60 per cent is obtained, while in the heating plant the same efficiency seldom exceeds 35 per cent.

As few steam power plants are operated at capacity, these plants should expand in their immediate locality, thereby increasing the amount of by-product or exhaust steam for heating, no new equipment being required.

As a war measure, we would suggest that steam power plants be kept running and not be shut down to buy their power and then in the winter months generate only heat. Make the steam do double duty. It is being done in many plants with a large saving.

Making 7,500,000 lb. of steam in a power plant would require approximately 1,000,000 lb. of coal, which would result in 7,000,000 lb. of steam for heating and 275,000 hp.-hr. of power.

In a heating plant, 7,000,000 lb. of steam would require approximately 1,750,000 lb. of coal for heat only, and the power required would be purchased from a power company which condenses all of its exhaust steam.

We take this opportunity to pledge our hearty cooperation in the work of the Fuel Administration and the War Industries Board.

Thanking you for your kind consideration, we remain,

Yours very truly,

Name	Chief Engineer of.

New System of Paying Allotments of Men in Service

A NEW method has been put in force for sending checks to families of men in the army or navy who receive allotments of pay or allowances from the government.

Dependents of a man getting $30 a month and alloting $15 to wife and children are not affected. Men receiving more than $30 are now required to make only $15 allotment except to wife and children when the compulsory allotment is $20.

If he wishes to allot larger amounts, he may make a new allotment for the difference through the War or Navy Departments, which will involve delay before the first checks are received.

The War Risk Insurance Bureau will in future handle only such allotments as carry allowances and will concentrate on getting checks promptly to dependents receiving money under such an arrangement.

Where a man has made an allotment through the Bureau, but has not asked for government allowance, the allotment will cease, unless the man makes a new application for allotment through the War or Navy Department.

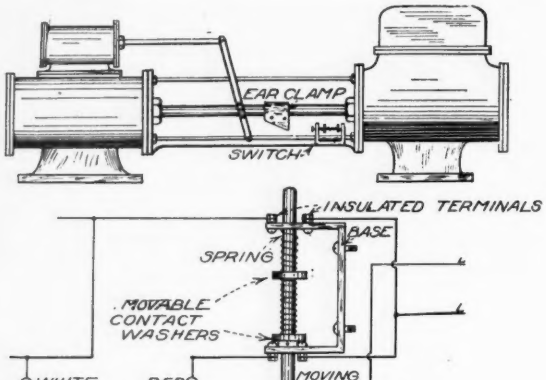
Where allotments carrying allowances have been made, they will continue to be handled by the Bureau, but the allotment will be either $15 or $20, the allowance being as before according to government regulations. If dependents find that their man has not taken the necessary steps to continue extra allotment through the War or Navy Department, they should write him urging that he do so at once.

For the army, such extra allotments will be handled through the office of the Quartermaster General, U. S. Army, Washington, D. C.; for the navy, by the Navy Allotment Officer, Navy Department, Washington, D. C.; for the Marine Corps, by the Paymaster, U. S. Marine Corps Headquarters, Washington, D. C.; for the Coast Guard, by the Captain Commandant, U. S. Coast Guard, Washington, D. C.

Making these changes will entail some delay in the receipt of checks, and the Home Service Agents of the American Red Cross have undertaken to relieve any resulting hardship to the families of enlisted men, even making payment of allotments and allowances from its own funds where necessary, until the new checks arrive. This is not a charity, but a loan against the delayed payments, and should be so regarded by recipients of such help.

Indicating Pump Light Switch

IN A PLANT where the pumps are located at a point distant from the engine room, and in the view of the engineer, some indicating device by which the operator may know that his pumps are working properly is almost indispensable. The switch shown in the accompanying sketch controls two lights, one of which lights for each stroke of the pump. It can be installed upon any reciprocating pump. When installing on some pumps, it becomes necessary to attach an ear to the pump shaft for actuating the switch. A person must use his own judgment about the placing of this ear upon the shaft, and of the switch upon the pump. The lights are best placed in some conspicuous or readily seen place in the engine room.



INDICATING PUMP LIGHT SWITCH AND METHOD OF ATTACHMENT

W. W. PARKER.

Improving Engine Economy

ON PAGE 618 of the issue for Aug. 1 appears the following statement: "In making valve adjustments, care should be taken to distribute the work between the two ends of the cylinder, so that the load is carried evenly on the two sides of the piston," etc. Then comes the following statement in the same paragraph: "The crank end should not be called upon to carry as much of the load as the head end," etc. As these two statements are directly in contradiction, which one does the writer expect us to believe?

In reply to his rather extensive remarks about the clearance of an engine, the following is offered: The late Prof. Robert Thurston made experiments which proved (at least to his own satisfaction), that attempts to fill the clearance space of an engine with steam left over from the previous stroke, and to compress it to a high pressure, are of no practical value. It takes power to compress the steam, and this power is given out by the expansion of the steam during the following stroke. His conclusions on the whole matter were that an engine ought to be given enough compression to make it run quietly, and no more.

I have made experiments by adjusting exhaust valves to give high and low compression, and could not show that it made the slightest difference in the consumption of steam.

At the end of the first paragraph on page 619 the following appears: "It can be reduced by placing a filler-in piece of iron in the cylinder itself to take up part of the dead space." That is correct, but what benefit will be derived from it? I once had charge of an engine that had a rather large clearance. The piston was drawn toward the crank as far as practicable, after which the engine was put on the head end center. The space between the piston and the cylinder head was measured, and a casting made that would fill this space, except ¼ in. in thickness. This was securely fastened to the cylinder head, thus reducing the clearance to this limit. I watched the result carefully, but could never show that it saved a dollar's worth of steam.

The next paragraph presumes to tell us something about the effects of leaks in a steam engine; but if Fig. 5 is correct, these leaks do not cause a loss in any case. It shows that the terminal pressure is the same in all three cases. The terminal pressure in all such cases is a true indication (as far as the indicator is concerned), of the loss sustained, but here it claims to show no loss at all. In reality, if the steam valve leaks and every other part is tight, the terminal pressure is higher than it ought to be for the stated point of cutoff. If the piston leaks, it will show a lower terminal pressure.

At the bottom of the first column on page 619, the following statement appears: "Another discovery made was that the governor was running too slow, and a larger pulley was placed on the driving shaft." This tells very plainly that a change in pulleys causes a governor to run faster, but in reality it will make no change whatever in the speed of the governor. When a belt governor is designed, it is destined to run at a certain speed, and if this speed is changed it must be due to some change in the governor itself, and not in mode of driving it.

On page 620 we read that "care should be taken to see that they are inserted so that the open ends of the various rings do not come at the same place in the piston periphery, since this may open a path for the leakage of the steam." A few days before writing this I put a

piston in the cylinder of one of my engines. I was careful to have the laps in the rings come together, and that is a very common practice, which does not tend to increase leakage of steam, but on the contrary it prevents such leakage. This piston is of very ordinary construction, with a cast-iron bull ring in which two broad grooves are turned, and a cast-iron ring is fitted into each of them. The relative position of these laps can have no effect on leakage, as they are entirely separate. They should always be located at the lowest part of the cylinder of a horizontal engine, because they are then covered by the bull ring as it rests on the bottom of the cylinder, and steam cannot blow directly through them.

On the same page we may read, "The most efficient governor for any engine is the one that will regulate the supply of steam so that the power developed is just sufficient to overcome all resistance when running at its normal speed." Will this writer explain what would happen if more steam was admitted than enough to overcome this resistance? My idea of it is as follows: If for any reason a defective governor admits more steam than is required to maintain normal speed, the speed is instantly increased. This causes the governor to reduce the supply of steam during the next stroke, hence normal speed is restored. No governor can continue to admit more steam than is wanted without producing this effect.

In the next paragraph we are cautioned against allowing a throttling governor to wire draw the steam, yet every throttling governor operates on this principle and cannot utilize any other.

In the latter part of the paragraph we are told that, "In order to increase the engine speed, the pulley on the shaft of the engine should be decreased." In another part of this article it is stated that changing the diameter of this pulley alters the speed of the governor. Which statement are we to believe, if we do not know for ourselves?

As a comment on the last paragraph of this article, the following incident is described. On being requested to find a remedy for a high-speed engine, which gave such unsteady speed that it could not be used, I found that the engineer desired to lower the speed of this engine which was fitted with a shaft governor. He decreased the tension on the springs and thus secured the desired result, but at the same time produced a bad case of "hunting." I increased the tension on these springs, also took a sheet of lead and cutting out circular washers, bolted them on to the governor until the desired speed was obtained. This cured the trouble mentioned, as the engine gave perfectly steady speed under all changes of load and variations of steam pressure, that were within the limits of the rated power of the engine. It will be noted that this result was secured by applying both of the remedies mentioned, and not by selecting one of them.

W. H. WAKEMAN.

MR. WAKEMAN'S letter commenting on the article on "Improving Engine Economy and Efficiency" has been noted.

In connection with the first point raised, Mr. Wakeman doubtless overlooked the qualifying statement reading, "Due allowance being made for the area of the piston rod on the crank end which area is ineffective as a result of which the crank end should not be called upon to carry as much of a load as the head end in such proportion as the area of the piston rod corresponds to the total area of the piston," which statement was embodied in the same sentence as the two abstracts which he mentions, and therefore should form part of them.

It would seem to be Mr. Wakeman's contention that clearance has no effect whatever on engine economy or efficiency, even when the clearance is so excessive as to permit the insertion of a filler-in piece, which his tests showed did not better conditions. Engineering practice and theory points to an opposite opinion. Concerning clearance Gebhardt says: "When the steam retained in the clearance space is compressed to the initial pressure and expansion is carried down to the back pressure, the clearance has little effect upon the economy of the engine; but since expansion and compression are seldom complete in actual practice, the loss may be considerable. The ratio of expansion is decreased by clearance; for example, an engine cutting off at 1/5, neglecting clearance has an apparent ratio of expansion of 5, but if the clearance volume is 10 per cent, the actual ratio is only 3.66." He also cites a test on a 14 by 15 Allfree engine, operating at 172 r.p.m. and 105-lb. gage pressure. With 2.2 per cent clearance volume the best performance was 23.7 lb. per i.hp. With the same speed and pressure, but with the clearance volume increased to 6 per cent by the use of a shorter piston, the best performance was 28.3 lb. In both cases the compression was carried to the admission pressure.

Figure 5 doubtless could have been improved by showing some change in the terminal pressure. It was drawn to show the effect of steam leaks in forcing the expansion line above or below the theoretical, which of course should have been carried to the end of the stroke.

In connection with governors the point is brought up that the change of driving pulleys will have no effect on the speed of the governor. A better statement of the case would be that when it becomes necessary to change the speed of the engine the pulley driving the governor must be adjusted to maintain the governor speed at the desired point. An engine can be speeded up by making the governor run slower by increasing the size of the pulley on the governor or by reducing the size of the driving pulley on the main shaft. Again while the governor and its drive is supposed to have been properly designed, this is not always the case, or the adjustment may have been changed or tampered with, making a change in adjustment necessary. If the governor is not kept up to speed it allows a longer range of cutoff than is required for the load carried, and as a result fluctuations in speed and steam waste are encountered.

The matter of placing of open ends of snap piston rings is largely one of personal opinions; however, it seems more logical that less leakage will take place through the open ends of the rings when they are placed at a distance from each other than when they are placed in close proximity to each other.

The reference to wiredrawing the steam through the throttling valve was intended to warn the operator against the use of too small a throttling valve, or one having restricted port areas. A throttling governor will

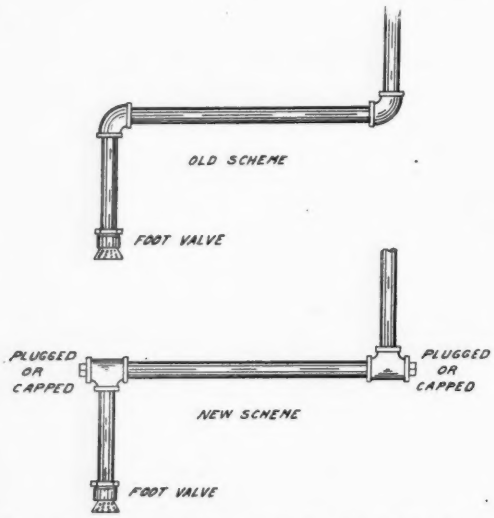
throttle down the steam, but need not necessarily cause wiredrawing in the sense that it is ordinarily used in engineering practice.

M. A. SALLER.

Improved Suction Pipe Line

AFTER DISMANTLING our suction pipe line, which recently had given us considerable trouble, we discovered certain sections almost filled with mud, leaves, etc., leaving but a comparatively small effective sectional area through which to draw water. In addition, the pipe had developed a bad crack, thus rendering it unfit for further use.

When we installed the new line, we employed two tees, as shown in the accompanying illustration. This arrangement allowed the occasional washing out of the



WITH THIS ARRANGEMENT THE PIPE LINE MAY BE READILY WASHED OUT

line and consequently also the removal of all mud, debris and so forth having a tendency to accumulate. I believe if suction lines were installed in this fashion, a great deal of trouble would be eliminated. DEAN B. COBB.

Hiring and Holding Men

UNDER THIS HEADING, J. O. Benefiel writes a very interesting article; however, I must differ from him right from the start.

He states: "I generally try to find out what a man's reputation is among his fellow engineers before hiring him."

Reputation is a valuable species of property or right, which should never be violated. With the loss of reputation, a man loses most of the enjoyment of life. What proof have you that "his fellow engineers" are competent and truthful and when asked regarding this man's reputation will "declare the truth, the whole truth, and nothing but the truth." Don't you think, Mr. Benefiel, that good fellowship, pull and a good line of bunk has, in a great many instances, much to do with the making or the breaking of a man's reputation?

Let's change this discussion from the "engineer" to the machinist, the molder, the pattern maker, and to workmen in general. It should be remembered that a workman is paid for what he knows as well as for what he performs, and, above all else, for the well-grounded knowledge of the principles of the trade, or profession, or the work in which he is engaged. The men most desired in the various departments of mechanics are the men who are familiar with the contents of technical magazines and good books, and as well, are the product of hard bought practical experience. In order to apply themselves to any advantage to serious study of the things pertaining to their trade or profession, they have very little spare time to give to "hob-nobbing" with some "hot-air" mechanic in order to gain the good-will and friendship of said hot-air merchant.

We often hear the remark, "He's a good fellow." I have heard this comment made about workmen who, at the work for which they were being paid, were not worth the space they occupied; and yet these same men were frequently asked questions pertaining to the character and ability of their fellow workmen. Today a man is a common workman or mechanic; he has neither ability or character; tomorrow he is made a foreman and is suddenly ushered into the limelight; because of his position he is frequently called upon and is free to express himself regarding the character and mechanical ability of his fellow workmen. References from men such as these are never asked for or accepted by good mechanics, and furthermore no reputable employer would give such references the slightest consideration. This is not intended as a reflection on Mr. Benefiel or his methods; however, during the 38 yr. that I have spent at the mechanical game, I have learned a few things about the hiring and the holding of men.

The master mechanic in a large rolling mill once said, "It's what the man does while in my employ that counts, and not what the other fellow said about him."

M. E. DUGGAN.

Cement for Pipe Joints

CEMENT for making screw joints in pipes steam tight may be made from graphite and heavy cylinder oil. Just enough oil is mixed with the graphite to form a thick paste.

A good cement for both water and steam pipes has this composition: Whiting, 4 lb.; fine yellow ochre, 10 lb.; ground litharge, 4 lb., and ½ lb. of hemp cut into fine particles. These ingredients are mixed thoroughly with linseed oil to form a paste, which is applied on the threads of the pipes, etc.

For ammonia piping, a cement made of litharge and glycerine is used. Sufficient glycerine is added to the litharge to form a putty. Only enough of this cement should be mixed to serve immediate needs, as it sets quickly. After having once set, it should not be disturbed. MARK MEREDITH.

Ventilating a Coal Pile

WE HAVE been reading some articles on the storage of bituminous coal with regard to its heating and igniting by spontaneous combustion.

The following is a simple remedy we have found very satisfactory: By using ordinary drain tile 3 or 4 in. in diameter, standing on end from bottom of bin to the top of the coal, spaced 6 or 8 ft. apart, we have cured our troubles and one side of our bin is adjoining our boiler walls, which adds considerable heat. J. A. WISE.

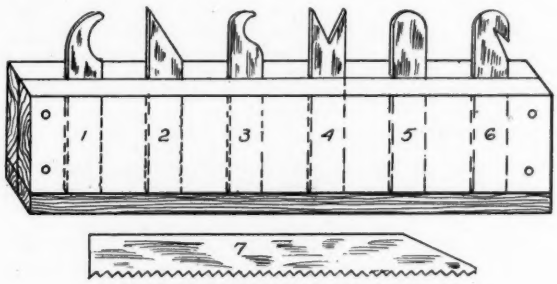
Making Tools from Old Hack-Saw Blades

QUITE A NUMBER of tools having a wide range of utility around the electrical maintenance man's bench can be constructed from old hack-saw blades. A small wooden case to stow the tools is made as follows: Two pieces of any suitable hardwood 8 in. long, 1½ in. wide and ½ in. thick are first cut out; on the flat side of these pieces several grooves are cut, large enough to allow a hack-saw blade to lie in it snugly.

The two pieces are then nailed together so that the grooves will be between both pieces. A third piece of wood, 8 in. long, 1 in. wide and ¼ in. thick is nailed on as a bottom piece. The case is now ready for tools.

While each of the tools can be used for several different operations, the writer will name a few of the most important uses. Numbers one, two and five are used mostly in taping coils. Numbers one and two are used to best advantage in digging stray drops of solder out of the winding of a stator after the connections have been soldered.

Numbers four and six, which have both edges of the V sharpened to a knife edge, are well adapted to cutting insulation and scraping wires or leads. Number seven is used to drive wedges into tight slots. By setting the



TOOLS MADE FROM OLD HACK-SAWS

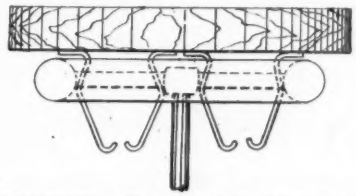
saw teeth on the wedge and pounding on the beveled end with a hammer, the teeth are made to grip the wedge and drive it to its proper place.

MAURICE M. CLEMENT.

Cool Valve Handle

IN A PLANT which the writer recently visited, a considerable amount of live steam at 75 lb. pressure was used for cooking and boiling purposes, and because of the special nature of the process involved, it was necessary to make frequent adjustments of the live steam control valve on each vat to meet the conditions. Complaint was frequently registered by the operators because of burns secured from the hot hand wheels on the steam valves, and while special composition, wooden and wire handles, were tried, the excessive heat was still encountered. As a result, the method was to use a piece of waste when handling the valve, though this was objectionable for a number of reasons.

The writer suggested that they use a supplementary wooden handle to be attached to the valve when controlling the steam, but to be slipped off the valve and hence out of contact with the heat when not required. Accordingly, a supplementary handle was made up as illustrated, from which it will be noted that by means of spring clips the extra handle is merely forced on and off the standard valve handle, the clips being so arranged that a snug fit is secured between the various spokes and the rim of the standard valve wheel. This supplementary handle was then attached to the pipe by means of a light chain from which it hung suspended in the air until such time as the valve was to be opened and

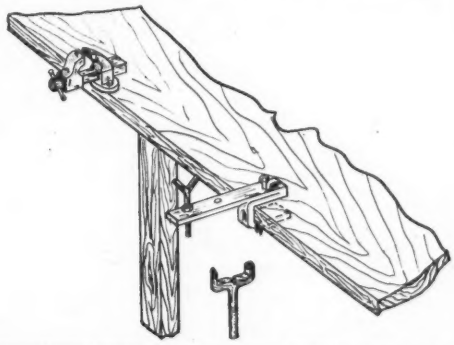


REMOVABLE HANDLE FOR HOT VALVES

closed, when it was within quick reach of the operator and could be forced onto the valve in a second's time and removed again after use. M. A. SALLER.

Support for Vise Work

ONCE USED, always used—no, this is not a patent medicine, but a homemade contrivance for holding up the end of a long shaft or piece of pipe when it is being worked upon in the bench vise. The device is simple, being made of one piece of 2 by ½-in. stock and a common 1-in. bolt, split at one end and bent to Y or U shape. A nut and washer are used to give adjustment for height. C. H. W.

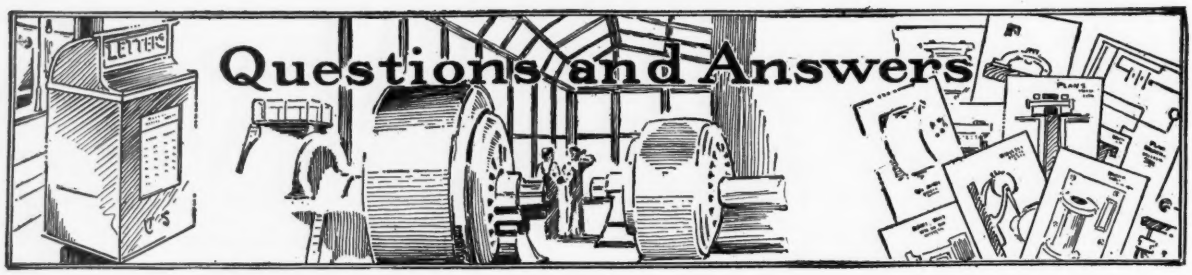


CONVENIENT SUPPORT FOR LONG PIECES HELD IN VISE

SO CAREFUL is the planning of the work of its fleet by the Shipping Board, that each day's work of each ship is reported on a progress chart showing where the ship should be, what it should have done, and what it has done. A merchant vessel arrives and another departs from some Atlantic port every 6 min., and from North Atlantic ports a ship leaves for Europe every 40 min. This is aside from vessels in the service of Army and Navy.

CHAIRMAN HURLEY reports that we have under contract or construction 819 shipbuilding ways, twice as many as in all other shipyards of the world combined. In June and July we produced more tonnage than during 1915 and 1916 combined.

ECONOMIZING may possibly hurt, but what of the hurts of the men who fight and die for you?



Question for Readers

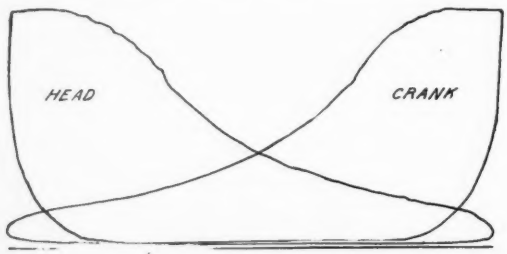
WHICH is the more economical both in wear and tear, and current consumption, to run a variable speed motor controlled by rheostat at full or less speed?

What is the quickest way to calculate the lever and the spring safety valve? Give rules and kinks that would pass on civil service test and United States Government marine license test.

I would like to hear from some of the engineers who burn hard coal. We get anything from No. 1 buckwheat to furnace; sometimes No. 1 buckwheat, pea, egg, furnace and a lot of dirt all run together. A. R.

What Causes Wavy Line?

I AM ENCLOSING herewith indicator diagram for criticism, taken from 34¾ by 60-in. Bates Corliss engine, running at a speed of 80 r.p.m., 120 lb. steam pressure, 60 lb. spring. After cutoff takes place on head end, a



CARD WITH WAVY LINE NEAR CUTOFF ON HEAD END

wavy expansion line is shown; this does not show on the crank end. What suggestions can be offered by readers of Power Plant Engineering? T. A. W.

Eliminating Salt from Boiler Water

WE ARE TROUBLED with salt water in our river here several months in the year; otherwise our water is first-class for boiler use. Do you consider it practical to build a tank and heat this water to overcome the salt feature before using it for boiler purposes; that is, will the mere fact of boiling the water overcome the salt trouble? G. S.

A. Boiling the water will not remove the salt from it, as salt will stay in suspension until there is a very heavy saturation. You would only bring down such salt as was held in suspension by the water actually evaporated, and the balance of the water would still retain its full quota of salt, or might even be more heavily saturated with salt than before.

Heating of the water in a closed tank, at high pressure, will throw down the sulphate of lime which is always present in sea water to a considerable extent, and will remove this incrusting material. The salt, sodium chloride, does not form incrustation to any great extent, except as mixed with the sulphate of lime. The difficulty comes from the priming and foaming, as you probably know.

The method usually adopted is to blow down the boilers frequently, as the greatest concentration of salt will be found near the bottom. This can be carried on until the salt content becomes about 50 grains per gallon, when all water should be let out of the boiler and fresh water put in.

Engine and Turbine Computations

IN FIGURING steam consumption of a cross compound engine, do you not divide the steam consumer in the high-pressure cylinder only by the total horsepower of both high-and low-pressure cylinders to obtain the steam used per indicated horsepower?

2. When using superheated steam, would the figures given in tables of properties of saturated steam be employed for finding the amount of steam consumed by an engine?

3. To determine the amount of steam used per kilowatt, would you divide the total amount of steam consumed by the product of the number of amperes times the number of volts, divided by 1000?

4. Can you give me any set rule by which to calculate the amount of steam consumed in a turbine? Also, how do you find the horsepower of a steam turbine? P. P.

ANSWERS

YOU ARE RIGHT, that in figuring the steam consumption on a cross compound engine, the steam consumed in the high-pressure cylinder only is divided by the total horsepower of both cylinders.

2. When using superheated steam, it will be necessary to use tables of Properties of Superheated Steam, such as published by Marks or by Goodenough. The volume of superheated steam per pound is not the same as the volume for saturated steam, and it is this volume on which the amount contained in the cylinder is estimated.

3. If you are using direct current, your method of finding steam per kilowatt—that is, dividing the steam consumed per hour by the (amperes times the voltage divided by 1000)—would be correct. If you are using alternating current, it would be necessary to multiply the amperes by the voltage and by the power factor of the system, to get the total watts.

4. There is no rule for finding the steam consumption in a turbine, or for finding the horsepower. The horsepower must be determined by a brake test, and the steam consumption by a steam test. The theoretical

steam consumption can be determined for an assumed set of conditions by the method shown in the issue of Jan. 1, 1918; but as to the actual steam consumption, the only method is to weigh either the water fed to the boiler which is supplying the turbine or the condensation from the condenser.

Gas Engine Heats, Due to Late Ignition

WHAT WOULD, in your opinion, be the cause of a gas engine's getting unduly hot (75 deg. C.) with a very light load?

It is a four-cylinder, four-cycle gas engine, ports and jackets having water forced through them by a rotary pump. It is in good condition. No water or oil passages are clogged. The viscosity of the oil is the same as is used in other engines of this type. J. J. G.

A. The probable cause of heating of your engine under light load is late ignition. With everything all right, the cooling system working properly and the oil in good condition, there should be no heating except from this cause.

You do not state where the temperature of 75 deg. C. is found, but this is not a very high temperature for a gas engine, unless you mean for the cooling water coming from the jacket; in that case, the temperature is somewhat high, but in any case we believe that advancing the spark will remedy your difficulty.

Economy Due to Tube Blowers

WOULD YOU advise the installation of set tube blowers on horizontal return tube boilers?

We have just installed a new boiler, and while the manager is willing to purchase set blowers, the boiler manufacturer did not encourage us to do so.

What is your opinion? A. M.

A. In tests made on boilers with and without set tube blowers, it has been found that there is a saving, by the use of the tube blowers, of 5 to 10 per cent. This is due in part to the fact that the tubes can be blown without opening up the boiler; in part to the fact that blowing can be done more frequently and effectively with the set blower than with the hand apparatus.

Return tubular boiler makers have, so far as we know, taken no positive stand one way or the other in the matter, but the large water-tube boiler makers are recommending the installation of set blower outfits on their boilers.

As a matter of economy in fuel and in labor, we believe you will find the investment a good one.

Steam Loss Through Pet Cocks

WILL YOU please tell me how many pounds of steam will go through a ⅛-in. pet cock at 15 lb. pressure?

We have quite a number of retorts for processing corn, upon which we use pet cocks to drain the condensation from the bottom of the retorts. We leave these open all the time and a good deal of live steam blows out and is wasted. I would like to get this information so as to know how much steam will blow through this size opening in, say, one hour's time, in order to figure whether it would pay to install small traps to take care of the condensation. W. T.

A. Rateau gives as a rule for calculating the flow of steam from an orifice at low pressures, pounds per hour = the area of the opening, in square inches, times 3.6, times the initial pressure, in pounds absolute, times (16.3 minus 0.96 × log of the pressure).

For 15 lb. atmospheric, the absolute pressure would be 30 lb., and for ⅛-in. pet cock the area is 0.0123 sq. in. Using these values, the flow would be 21 lb. of steam per hour through the ⅛-in. pet cock.

A check on this is given by a table of values for steam turbine nozzles, which for a converging nozzle shows 19.8 lb. per hour for a nozzle ⅛ in. in diameter, with steam at 30 lb. pressure, flowing to atmosphere.

The rule by Rateau is for conditions where the exhaust pressure is less than 0.58 of the initial pressure. In your case, this is not quite true, since 0.58 of 30 would be 17.4, and this probably accounts for the difference between the 21 lb. and the 19.8 lb. value.

Alloy For Fusible Plugs

WHAT IS the best alloy for use in fusible plugs? H. W.

A. The only filling recommended for fusible plugs is pure Banca tin. Any other alloy is found to have a widely variable melting point, and cannot be depended upon.

While in some instances an alloy has been used in place of the tin, to give a lower melting point, it has been found that this is not reliable, and the pure tin has a melting point low enough, with a properly installed fusible plug, to take care of overheating before it becomes dangerous.

You Are Doing It

EVERY TIME you read, you purchasers of Liberty Bonds and War Savings Stamps, of what the United States is doing in France in building wharves and railroads, or deluging the Germans with gas or shelling them out of position with big guns or shrapnel, or of bombing their arsenals or cities, or of the great work of our Army and our Navy, or of the building of ships here, or of any or all of the great or small achievements of America, here or abroad or on the seas, you buyers of Liberty Bonds and War Savings Stamps truthfully can say, "I had a hand in this"; "I contributed to this"; "I am helping do this"; "It is part of my work."

THE UNITED STATES is not the only country where coal is a real problem. Under a new agreement, Switzerland is allowed by Germany only 200,000 t. of coal a month, and the price is $33.38 a ton for manufacturing purposes and $25.66 a ton for household purposes. Also, there is a long list of goods, which affects especially machine and chemical works, which cannot be exported if German coal has been used for their manufacture. The relief is that some 5000 t. of coal a month are needed for these manufactures, and the allies supply about 8000 t. a month.

Brazil, during April, received 43,868 t. of coal as against 56,761 t. in April, 1917, and 85,457 t. in April, 1916. Of this the United States supplied 12,042 t. and Great Britain the balance.

AFTER ALL, saving is not sacrificing.

Annual Convention of the Smoke Prevention Association

THE thirteenth annual convention of the Smoke Prevention Association, held at Newark, N. J., Aug. 20-22, inclusive, proved to be one of the most successful gatherings in the history of the organization, with a total attendance of over 50 delegates from all parts of the country. Even though a smaller attendance than usual had been anticipated, due to the fact that many members are engaged in war service, a spirit of enthusiasm and undivided interest was evidenced at the different business sessions held in the McCarter Gallery. The program and various entertainment features were arranged by Daniel J. Maloney, Newark, smoke inspector for the city and first vice-president of the association.

The opening session, Tuesday morning, Aug. 20, was devoted to preliminary matters in connection with the gathering, William A. Pittsford of the Kewanee Boiler Co., Kewanee, Ill., acting as temporary chairman in the absence of President William H. Reid, Chicago. Mr. Pittsford made reference to an advance copy of a new book, compiled by Mr. Maloney, covering smoke regulation and coal conservation, saying that he was entitled to unstinted praise for this composition, which gave far-reaching evidence of the value of the work of the smoke inspector and the extent of his accomplishments. This book, arranged for general distribution in the city, is designed to be of value to stationary engineers, firemen, owners of power plants, consulting engineers and others in the field; finished copies of the booklet were given to the delegates before the close of the convention.

At the afternoon session, Mayor Gillen welcomed the visitors to the city, calling attention to various features of general interest along industrial lines in the municipality. The opening business address was made by Newell W. Roberts, vice-president of the International Coal Products Corporation, New York, on the subject of "Carbocoal," a new smokeless fuel now being manufactured in the Irvington section of Newark. This coal, made in briquet form, is produced from high volatile bituminous coal, composed principally of fixed carbon and with all important elements of a perfect fuel. It contains about 1½ to 4 per cent volatile matter. So successful have been the results attending the use of this fuel that the Government is building a plant at Clinchfield, Va., to cost about $2,000,000 for its manufacture; it is the intention to devote production to the use of the navy and merchant vessels in the submarine zone. It is planned to have the plant ready for operation early in 1919.

During this afternoon session papers were presented by Frank W. Casler, General Superintendent of Production, Public Service Corporation of New Jersey, on the subject of "Experience of Burning a Million Tons of Coal a Year and How We Supervise It"; by A. H. Blackburn, Chief Engineer of the Underfeed Stoker Co. of America, Chicago, devoted to "Boiler Room Efficiency"; and a resume, "Smokeless Combustion with Chain Grate Stokers," by Thomas A. Marsh, Chief Engineer of the Green Engineering Co., East Chicago, Ind. Abstracts of these papers will appear in an early issue of Power Plant Engineering.

On Tuesday evening a special motion picture exhibit was given at Proctor's Palace Theater Roof Garden, Market Street, for the delegates and guests. Among the films shown was "The Troubles of a Building Owner," made by the Kewanee Boiler Co., Kewanee, Ill., distinctly applicable to the subject of smoke prevention.

The Wednesday morning session was devoted to an illustrated lecture by William A. Pittsford, Kewanee Boiler Co., on the subject of "Bituminous Coal for Heating Boilers," dealing particularly with low-pressure boilers and furnaces for house heating service. In the afternoon, an automobile trip was made to the Newark watersheds at Pequannock, a total round-trip distance of over 80 miles. An informal reception to members and guests was held at the hotel in the evening.

Thursday was given over to business sessions covering features of locomotive operation and the prevention of smoke, designated on the program as "Railroad Day." The first address was made by Thomas F. Lee, Woodhaven, L. I., on the subject of "Smokeless Combustion of Fuels," and covering a series of personal experiments and experiences in connection with the development of a new stoker. Following an interesting address was made by H. D. Savage, vice-president of the Locomotive Pulverized Fuel Co., New York, termed, "Burning Pulverized Fuel," and showing the advantages attending the use of powdered coal on different railway systems. An equally interesting paper was presented by W. S. Bartholomew, of the Locomotive Stoker Co., Pittsburgh, on the subject of "Mechanical Stoking of Locomotives as Related to Smoke Prevention Problems." The regular session for the presentation of papers was brought to a close by C. D. Van Schaick, Combustion Expert, New York Central Lines, who gave a short informal talk on "What Is Smoke"?

The following officers were elected for the ensuing year: President, Warren A. Edson, Boston, Mass.; first vice-president, W. H. Corbett, Michigan City, Ind.; second vice-president, William A. Pittsford, Kewanee, Ill.; and secretary-treasurer, Frank A. Chambers, Chicago, Ill. (reelected to this office). Chicago was selected as the next convention city, with the time of meeting to be fixed by the secretary at a later date. It was voted to arrange for an exhibition hall at the next annual meeting for the use of manufacturers of power plant equipment, with booths for individual display.

AT THIS TIME when our boys are giving their lives that democracy and decency may live, the man who does not do his individual part of kindliness and good feeling to clinch the citizenship which "first" and "second" papers have bestowed, is failing his own son, if that son be on the fighting line; is failing his own wife, if that wife's house is not to be invaded; is failing the memory of his father who fought to make men free in this country, is failing his forefathers who fought to give men a chance, a flag and a country.—A chance and a flag and a country which the foreign-born citizen has sought, as the chance, the flag and the country which he believes to be best for him and his.

Limitations Upon Storage of Coal

TREMENDOUSLY increasing demand for coal for special war purposes in the eastern part of the country, particularly for the navy and transport service is making it necessary to draw more heavily on the eastern coal fields than was originally contemplated.

At a meeting of all State Fuel Administrators east of the Mississippi and also the States of Minnesota, North Dakota and South Dakota, held in Washington on Aug. 20, it was decided that it would be necessary to limit the amount of coal storage that industrial plants would be allowed to accumulate and to carry on hand and to fix a uniform amount for each State.

The following report, framed by a committee of State Fuel Administrators, aided by officials of the Administration, was adopted by the conference and concurred in by Dr. Garfield:

"The maximum limits of storage indicated for the several states or parts of states defined hereafter are as follows:

MAXIMUM NUMBER DAYS STORAGE BITUMINOUS COAL ALLOWED UNTIL FURTHER NOTICE

	Steam Coal.			By-Product and Gas Coal.		
	Public Utilities.	Preferred Industries.	Non-Preferred Industries.	By-Product and Gas Plants.	Preferred Industries.	Non-Preferred Industries.
Maine	120	90	30	120	90	0
Mass., Vt., N. H., Northern N. Y.	90	60	30	90	60	0
Conn., R. I.	75	45	20	75	45	0
Southern N. Y., N. J., Del., Eastern Pa.	30	30	15	45	30	0
Md., D. C., Va., N. C., S. C., Ga., Fla., Western Ohio	30	30	15	45	30	0
Western Pa., W. Va., Eastern Ky., Eastern Ohio	30	20	15	45	30	0
Lower Michigan	90	45	20	60	60	0
Ill., Ind., Mo.	..	..	..	60	60	0
Wis., Minn., N. D., S. D., Upper Mich.	..	..	..	90	90	0

"It is understood that these limits are mandatory and each Fuel Administrator is expected to see that the different classes of consumers are not allowed to exceed these limits. At the same time, it is understood that particular cases may require special treatment by a State Fuel Administrator, either by way of granting more stocks of coal than are indicated by these limits, or by restricting them to a less supply than indicated by these limits.

"Where a State Administrator decides that the maximum limit should be exceeded in a special case for some special reason, he shall have authority to grant in writing a revocable increase for a specific added number of days. The administrator shall report each such specific case in writing immediately to the United States Fuel Administration at Washington, which may in writing disapprove the extension granted by him. Otherwise, it shall stand subject to action of the State Fuel Administrator.

"Any company or concern which is permitted under the zoning regulations now or hereafter in force to obtain coal from Illinois, Indiana, Western Kentucky, or from mines west of the Mississippi River, may retain such reserve stock of coal as it shall have on the effective date hereof, on condition that such company or concern shall thereafter use screenings or mine run only, for its current necessities, and shall obtain such screenings or mine run for current use only from such last mentioned fields."

Exchange of Liberty Bonds

ACCORDING to information obtained at the Government Bond Department of the Federal Reserve Bank of Chicago, only about $95,000,000 of the 4 per cent Liberty Bonds have to date been presented for conversion into 4¼ per cent bonds. Of this amount $12,000,000 are 4 per cent bonds of the First Liberty Loan converted and $83,000,000 are Second Liberty Loan 4 per cent Bonds. There were issued in this Federal Reserve District a total of $88,000,000 First Converted Fours and $527,000,000 Second Fours.

It appears, therefore, that only about one-seventh of these holders of 4 per cent bonds have taken advantage of the opportunity to secure 4¼ per cent on their investment.

The 4¼ per cent conversion bonds are now available for prompt delivery in coupon form. Deliveries of registered bonds require more time for opening accounts, preparation of address plates, checking and verifying names, inscribing bonds, etc.

Bond holders should understand that they will not automatically receive 4¼ per cent interest on their bonds without action on their part. Strange as it may seem, there is hardly a doubt that millions of these bonds are in the hands of people who may put them away for years without even clipping and collecting the interest coupons. It is said that some of the United States 3 per cent bonds due Aug. 1, 1918, have been presented for payment with all the matured coupons attached. If this could occur in the case of an issue of bonds of which only $63,000,000 were outstanding and of that amount all but about $15,000,000 in the hands of banks, almost anything can be expected where billions of dollars of bonds have been sold to many millions of subscribers.

The conversion privilege on 4 per cent bonds of both the First and Second Liberty Loans expires on Nov. 9, 1918, and they cannot be converted into subsequent issues of United States bonds which might come out at a higher rate. Therefore, holders of 4 per cent Liberty Loan Bonds should in every case present them for conversion. By converting these bonds they will not only receive ¼ of 1 per cent additional interest, but after the conversion period has expired (Nov. 9, 1918) there will undoubtedly be several points difference in the market price of the 4 per cent and 4¼ per cent bonds.

It is best for bond holders to arrange for the conversion of their bonds through the bank which handled the original subscription; but those who have changed their place of residence can, without doubt, handle the matter through any convenient bank.

CEMENT AND SAND—3 to 1 mixture—sprayed on mine timbers, by compressed air, renders them fire-resisting to a considerable degree. Any desired thickness may be built up by spraying in layers, by the cement gun.—COMPRESSED AIR MAGAZINE.

BECOME a stockholder in the United States—buy War Savings Stamps.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.
(Established over 22 years.)
Formerly PRACTICAL ENGINEER
PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

BY THE TECHNICAL PUBLISHING CO.
537 South Dearborn Street,
CHICAGO, ILL.

New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1918, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue 23,400.

CONTENTS

More Energy for Mansfield District. Illustrated.....733
Pressure Losses in Steam Plants. By R. S. Hawley. Illustrated 739
Power Plants and the Fuel Administration. By A. P. Connor. Illustrated.....741
Handling Jones Underfeed Stokers. By Receiver. Illustrated 743
Using Navy Compound. By A. C. McHugh.....745
Improving Factory Steam Plants—III. By H. A. Wilcox..747
Coal Storage Systems for Power Plants. Illustrated....750
How to Increase Artesian Well Supplies. By Frank Bohl..753
Cross Connection of Reverse-Power Relays. Illustrated..754
Pointers on Storage Battery Operation. By T. H. Reardon 755
A Fair Deal on the Job.....756
Factory Chimney Repairs. By Mark Meredith.....757
Fourth Liberty Loan.....757
Rebabbiting a Thrust Bearing. By Babbit. Illustrated..758
Suggestions to the Fuel Administrator.....759
New System of Paying Allotments of Men in Service.....759
Letters Direct from the Plant: Indicating Pump Light Switch. Improving Engine Economy. Improved Suction Pipe Line. Hiring and Holding Men. Cements for Pipe Joints. Ventilating a Coal Pile. Making Tools from Old Hack-Saw Blades. Cool Valve Handle. Support for Vise Work. Illustrated.....760
Questions and Answers: Question for Readers. What Causes Wavy Line? Eliminating Salt from Boiler Water. Engine and Turbine Computations. Gas Engine Heats, Due to Late Ignition. Economy Due to Tube Blowers. Steam Loss Through Pet Cocks. Alloy for Fusible Plugs. Illustrated.....764
Annual Convention of the Smoke Prevention Association..766
Limitations Upon Storage of Coal.....767
Exchange of Liberty Bonds.....767
Editorial: Operating on Central Station Service.....
Block Power and eHating Plants.....768
Editorial: Operating on Central Station Service. Block Power and Heating Plants. 768
Features of the New Coppus Turbo Blower. Illustrated..770
A Safety First Relay. Illustrated.....771
Pressure Governor for Gas and Liquid System. Illustrated 772
Blake Illuminated Fuse Tester. Illustrated.....773
Building a Firm Engine Foundation. Illustrated.....774
Book Reviews 774
Practical Reference Tables: Thickness of 85 Per Cent Magnesia for Maximum Net Saving. Material Required for 1 Cu. Yd. Concrete. Cost of Materials for Concrete 775
Catalog Notes 777

Operating on Central Station Service

An interesting situation from the standpoint of personnel now and then arises in connection with an industrial power installation which has either gone over to central station service or which has been designed for operation without a plant of its own. To what extent should installations of this character require the services of engineers holding first-class licenses? Is such a job worth having from the standpoint of the progressive operating man?

The answer to these questions of course depends upon the size of the installation, the scope of the duties embraced in the engineer's responsibilities, the opportunity for original work and the compensation allowed. In some cases, certainly, there should be a real opportunity for an engineer holding a first-class license to make himself a vital factor in the success of the installation. Take the instance of a seaboard terminal now under construction, where the installation will comprise scores of motor-driven elevators, industrial electric trucks, electric hoists, lighting, power, fire protection, water supply, drainage, heating, compressed air, pumping and telephone service. Central station energy will be purchased in this case, and the only steam plant service required will center about the heating system. Property valued at millions of dollars will be in the hands of the operating staff, and the superintendence of such an installation will be a vital factor in the speed with which standard cargo carriers produced by the United States Shipping Board will be loaded and dispatched to Europe with army and naval supplies. Yet because the use of high-pressure steam will be either negligible or not required at all in this installation, the question arises whether an operating man holding a first-class license would not be wasted upon such a layout. Does such a post offer a man competent to operate a 15,000-kw. steam turbo-generator and a corresponding battery of high-pressure boilers and mechanical stokers, with superheaters and all the other "fixin's" of a high-class station, enough interest to warrant his taking charge?

As a war service, we believe that a first-class engineer would do well to take command of such an installation. The opportunities to line up a layout of this kind for efficient use, and to maintain it in A1 condition for immediate service at any hour of the day or night when a convoy arrives, seem unusually attractive. Of course, an engineer holding a license below the first grade could operate such a plant; but assuming that those responsible for its success see in an engineer something far above a mere janitor with mechanical skill and are willing to place the equipment in his charge as a professional expert, back up his recommendations when they are demonstratedly sound, and arrange for co-operation between the terminal superintending officers and the engineer, the post ought to be well worth taking.

Where a great variety of automatic and semi-automatic equipment is in service, its efficient use depends in no small degree upon what might be called anticipatory maintenance, upon careful studies of service cost and performance, with competent technical analyses of unit and grouped equipment efficiency. The mere fact that such an installation does not require a high-pressure steam plant generating its own electrical energy ought

not to debar it from service of a high-class engineering executive used to power distribution service. Ultimately, perhaps, the service of such a terminal might become so standardized as to offer little incentive for the continuous employment of an operating engineer of the most advanced grade; but that would depend upon future developments. Should the engineer come to be regarded by his superiors as a cross between a plumber and an electrician, to be called hither and yon with little or no opportunity to display his own technical judgment, it might easily be inexpedient to remain in statu quo. But the chieftaincy of such an installation should not be turned down flat at the outset simply because the engineer nominated to take charge of its equipment destinies finds central station energy supply to be the basis of its operations.

Block Power and Heating Plants

Absorbing the thought of engineers throughout the country today is the problem of utilizing every available heat unit in the fuel used to serve mankind. The question today is not so much one of economy in dollars and cents as in the amount and kind of coal that must be used to give the desired results. It is, of course, recognized that every type of plant encounters certain losses which are impossible of elimination. Steam plants designed to give a special service subordinate all other possible services to the one main aim. In this way, that one product may in many cases be made cheaper than in a plant designed to give two or more services. For example, a plant designed to produce power alone is in most cases so designed as to deliver more power to the switchboard per pound of coal than is done in a plant designed to furnish both heat and power. And on the other hand it is theoretically possible to furnish more heat per pound of coal to a heating system when the steam passes directly from a boiler to the radiators than when it goes through an engine on the way; practically, however, it is the experience of engineers that less weight of steam is used for heating with exhaust steam than with live steam which has been passed through a pressure-reducing valve.

It is equally feasible to design a plant giving both heat and power services, when conditions are right, that will utilize more heat units of the coal used than can be done in either the specialized power or heating plants. The conditions are ideally right when the heating load requires all but no more steam than is exhausted from the steam driven machinery in excess of that used for heating feed water. This condition, of course, does not exist in any plant continuously owing principally to changes in weather conditions, but an expert designer of power plants can make a selection of machinery which will give much better economy of heat units during the heating season of the year than can be obtained when power and heat come from separate central plants as they are ordinarily operated today.

All this brings us to the conclusion that in congested city districts where both power and heat are necessary the logical arrangement would be to employ block or small district plants equipped with the most efficient machinery for the purpose, the size of the plant being large enough to compete fairly with the central steam power station. In some cases it may be found advisable to run on central station power during the summer months, but when the exhaust steam is used for heating or industrial purposes the block plant should prove most economical.

Power Plant Engineering is therefore in full accord with the suggestion made to the Fuel Administration by a number of chief engineers of Chicago office building plants and published on another page of this issue. Undoubtedly the Administration could exert its authority to bring about the establishment of block systems that would mean a great saving of coal.

Time for Erecting Marine Engine Cut 30 Per Cent

SLOW PRODUCTION of marine engines and power equipment for completed hulls, occasioned by many ungovernable factors, has been one of the chief causes of delay in getting numerous completed hulls into service to relieve the pressing need for cargo vessels in the transport of troops and supplies to the battlefield, but occasionally there are bright spots on the horizon.

One of these is the feat of the Sun Shipbuilding Company, Chester, Pa., in erecting a complete marine engine of 3000 hp. in 15¼ hr., cutting the average time from 30 to 35 per cent.

The record is reported by Robert Haig to Daniel H. Cox, manager of the Division of Steel Ship Construction United Shipping Board Emergency Fleet Corporation. He says: "On Aug. 5 we erected, at the Wetherill shops of the Sun Shipbuilding Company, two complete sets of marine engines of 3000 hp. each, in 30½ hr. The work included the total assembling, erection of the completed engines, cutting the piston rods, valve spindles and pump rods to the required lengths, making the time of erection and completion of one reciprocating engine 15¼ hr."

The Emergency Fleet News invites accounts of other records that will compare favorably with this.

IN A REPLY to criticism of operation of the railroads by the government, Theodore H. Price, actuary to the U. S. R. R. Administration, states that, although the ton-miles carried during the first 5 mo. of 1918 were 0.6 per cent less than for the like period of 1917, this was accomplished with 8.6 per cent less car miles, due to heavier loading of cars and shipping by the shortest route, rather than letting the shipper select the route. He adds that if this ratio of gain be continued, it will be equivalent to adding 211,200 cars and 1750 locomotives to present equipment.

The average carload has been increased 8.8 per cent and in several cases freight routing between important cities has been shortened by 200 to 500 miles. Mr. Price claims that there is now no shortage of cars for coal mines and no congestion or delay, and that the Railroad Administration has of late been urging merchants to take advantage of present carrying ability to stock up for the winter.

Experience of shippers and reports of the Fuel Administration as to loss of capacity at coal mines because of lack of cars does not seem to coincide with these last statements, but it is possible that conditions have recently improved. At any rate, it is to be hoped that

Features of the New Coppus Turbo Blower

CONTAINING the best elements used in modern turbine and blower practice, arranged to suit the hard usages to which a turbo blower is subjected, the new Coppus turbo blower described below may be installed to solve nearly all forced draft problems met in boiler furnace practice.

The turbine casing A is supported from the fan casing B by substantial studs C and exhaust pipe D. The shaft E with its ball bearings is mounted within

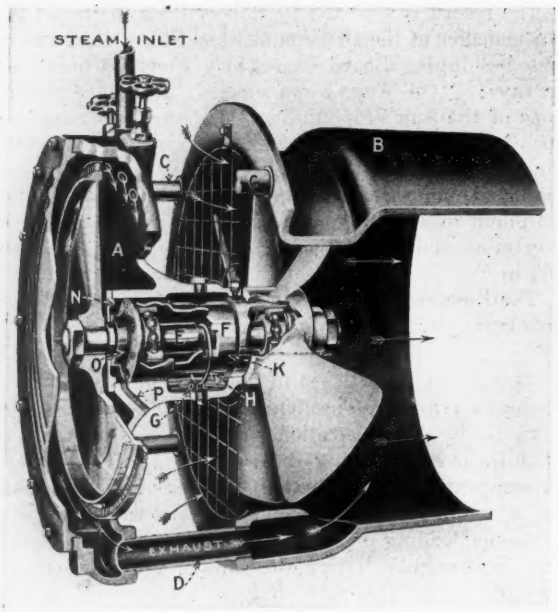


FIG. 1. SECTIONAL VIEW COPPUS TURBO BLOWER TYPE C

the motor bushing F, which is provided on both ends with enclosures. The complete motor is inserted bodily into the housing of the turbine casing and forms with it the oil chamber G. Oil ring H, which hangs from the shaft into the oil chamber forces the oil through the bearings after which the oil is returned to the oil chamber. The shaft carries on one side the turbine disk which is held on the shaft by means of key and lock nut. The fan on the opposite end of the shaft is similarly held in place. Proper provision is made for sealing the turbine casing so that no exhaust steam or water can enter the oil chamber, while the oil chamber is also properly sealed to prevent oil from leaking out.

The oil ring H takes the oil from the oil chamber G and in the usual manner conveys it to the shaft E. By means of the "V" groove in the shaft E the oil is distributed on the shaft towards both bearings and thrown off in their direction. It runs down on the inside of the motor bushing F and collects on either side of the dam I, and flows by gravity towards each bearing. Not only by gravity, but also through the peculiar action of the ball bearings the oil passes through the bearings and returns through canals J to the oil chamber G. The dam I prevents the oil which is thrown off the shaft from flowing in one direction in case the blower should not be set perfectly level, and thus lubricating only one bearing. One single oil ring, therefore, supplies two separate oil chambers, one on each side of the dam, and each bearing will receive an abundant supply of oil regardless of whether or not the blower is set perfectly level.

When the oil chamber is filled the oil level is approxi-

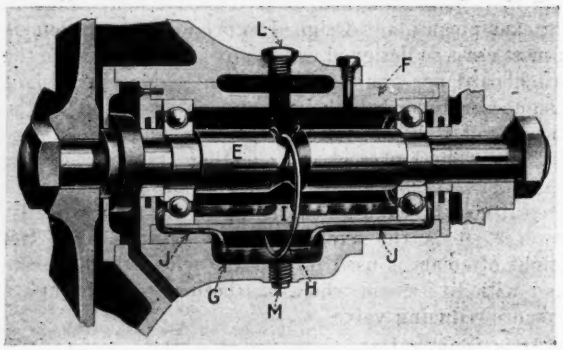


FIG. 2. SECTIONAL VIEW BLOWER BEARING

mately at the center of the balls of the bearings and the two upper oil chambers on each side of the dam form with the lower oil chamber G one large oil reservoir. As long as the oil supply does not diminish the function of the oil ring H is simply to create a circulation of the oil through the ball bearings.

When the oil supply diminishes the original oil level in the upper oil chambers is still maintained as long as the oil ring touches the oil in the lower oil chamber G. Experiments showed that the oil ring drew so much oil from the oil chamber that the return canals J could not take care of it. Therefore the motor bushing was provided with the overflows K so that no more oil than the return canals could take care of would collect in the upper oil chambers of the motor bushing.

To fill the oil reservoir the plug L at the top of the hub of the turbine casing is removed and the overflow pet cock at the side of the casing is opened. When oil

flows through this pet cock it is closed and the plug L replaced.

When it is desired to clean out or refill the oil chamber, the plug M at the bottom of the oil chamber is removed.

To facilitate repairs the bearings are mounted in the motor bushing which is inserted in the hub of the turbine. If any of the moving parts of the machine should need attention, the motor bushing could be removed as a whole and a new one put in in less than an hour. The system of interchangeability of parts is carried out in minutest detail.

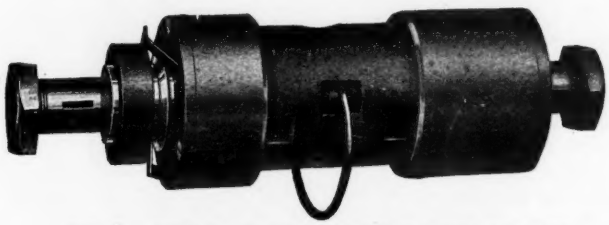


FIG. 3. VIEW OF BEARING REMOVED FROM HOUSING

The construction of the blower contains no stuffing boxes, but requires sealing against the discharge of steam from the turbine casing in only one place. For this purpose a floating solid carbon packing ring Fig. 3, is employed, which is steam tight on a ground shaft for low pressures, cannot and does not need to be adjusted, and is self-lubricating. It is held against the enclosure N by means of springs, is prevented from turning by means of a pin in the enclosure N, and yet can move up and down with the shaft if the ball bearings should become slightly worn. If any vapor should work by this packing ring, it would enter the chamber, located between the turbine casing and the motor bushing, and which is open to the atmosphere through a wide slot P. It would therefore pass out and enter with the air into

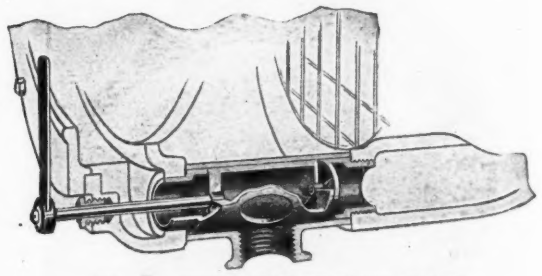


FIG. 5. THREE-WAY EXHAUST VALVE

the fan casing. Any drops of water which might work by the packing ring would be caught by the throw ring on the distance bushing and would similarly pass pass out. No steam or water, therefore, can enter the oil chamber and rust the bearings.

The exhaust is located at the bottom of the turbine casing and is connected to the fan casing by means of a substantial pipe which gives additional support to the turbine casing. The exhaust steam is discharged in front of the fan and mingles thoroughly with the air. If it is desired to take the exhaust steam away from the ashpit entirely, a diverted exhaust is provided, but the pressure against which the exhaust steam is discharged should not be over 5 lb. This exhaust pipe can be so placed that the exhaust may be taken from either side or from the bottom as shown in the cut.

Sometimes it is desired to use part of the exhaust steam in the ashpit and divert the rest. For this condition, a special three way exhaust valve is furnished. It takes the place of two other valves or three way cocks and will discharge steam in more than one direction and remain fully open no matter in which proportion the steam is discharged. This insures against any accident to the steam turbine. In other words, in one extreme position all the steam is discharged into the ashpit, in the other extreme position all the steam is diverted, while in any intermediate position part of the steam is diverted from and part of the steam discharged into the ashpit, but the total discharge openings always equal the total capacity of the valve.

Special attention has been given to the design of the fan casing in order to insure the highest efficiency. The casing closely hugs the fan and is expanded immediately

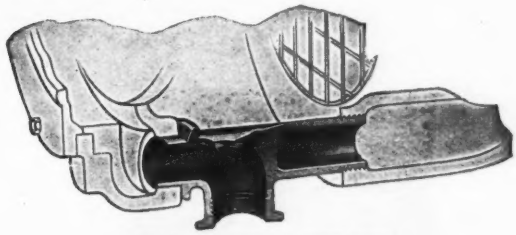


FIG. 4. DIVERTED EXHAUST

beyond. This relieves the choking effect on the air by the casing, greatly eliminates friction, and prevents the formation of eddy currents. The most efficient point of expansion has been determined by accurate tests.

This blower is the product of the Coppus Engineering & Equipment Co., of Worcester, Mass.

A Safety First Relay

WAR-TIME conditions demand that the utmost care be taken of both machines and men in the factory and shop. The safety first relay manufactured by the Westinghouse Electric and Manufacturing Co. provides a neat, safe and efficient method of supplying overload protection for alternating current applications equipped with starters or switches having low-voltage protection.

The relay is enclosed in a sheet steel case which excludes dust and foreign particles of all kinds. The cover of this case is secured by two thumb screws and is provided with a safety device which automatically trips the relay when the cover is removed, thus rendering all parts of the relay "dead" as long as the cover remains off, so that inspection or repairs can be made without danger.

This case is arranged for wall-mounting in any convenient place near the switching equipment.

The relay operates by means of magnet coils, which are inactive at loads less than that for which they are set. When the current value reaches or exceeds this setting, the coils lift plungers which break the control circuit and operate the low-voltage relay to open the line

circuit. With no current flowing in the line, the coils are de-energized and the relay is automatically reset, the bridge being pressed against the contacts by means of a compression spring.

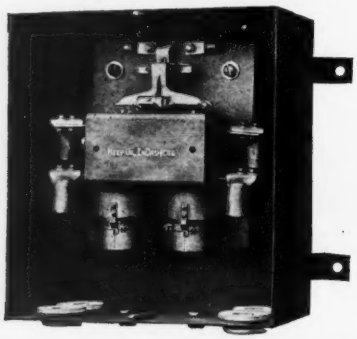
The plungers operate in oil dashpots, providing a time element which allows the relay to carry a momentary overload without tripping.

This time limit is adjustable by means of a small perforated disk in the dashpot, which is readily accessible by unscrewing the dashpot from the casting which holds it. Turning the disk so that more perforations are uncovered lessens the time of the momentary overload; with fewer perforations, the time element is increased.

These relays will operate over a wide range of current values, for which adjustments can readily be made by lowering or raising the dashpot. This is marked with a scale, and an indicator clearly shows the tripping value.

To prevent accidental change of adjustment from vibration or jar, a spring lock is provided which holds the dashpot firmly.

The relay is mounted on a base which completely insulates it from the case, within which all connections are made. This case can be arranged for either open or conduit wiring.



WESTINGHOUSE SAFETY FIRST RELAY

The safety device by which the relay is tripped on removal of the cover is a flat looped spring which when free to act holds the contact bridge away from the contacts. When the cover is fastened in place, this spring is depressed by a pin on the cover, thus allowing contact to be made between contacts and bridge.

These relays are made in all commercial frequencies and voltages, and in capacities of 5 to 300 amp.

Pressure Governor for Gas and Liquid System

IN many power installations where air, other gases, or liquids must be maintained under pressure, the demand for an automatic method of doing this has arisen. As a result, the General Electric Co. has developed a new pressure governor to control standard self-starters for motor-operated pumps and compressors. The governor maintains a pressure between predetermined limits on any gas or liquid systems the contents of which will not corrode the Bourdon tube.

This governor is called the CR 2922 and can be used on any standard alternating or direct curent circuit. It is rated for pressures of 80, 100, 160, 300 or 500 lb. and operates within settings of from 3 to 12 lb. between high and low pressures.

Governors for higher pressures can be supplied if desired.

The governor consists of a Bourdon tube, an indicating needle, a graduated pressure scale, adjustable high and low pressure stops to determine the desired pressure

FIG. 1. EXTERIOR VIEW OF PRESSURE GOVERNOR

range and a relay which actuates the contacts in the control circuit of the self-starter, all enclosed within a dust-proof case, easily opened for inspection.

Action of the governor is dependent on the Bourdon tube, which should be connected to an independent discharge pipe from the pressure tank. The free end of the tube T is mechanically connected to the indicator needle

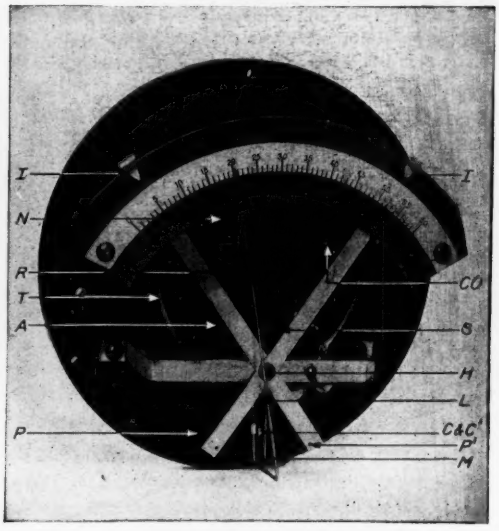


FIG. 2. INTERIOR OF PRESSURE GOVERNOR EXPOSED

N, moving it over the scale as changes of pressure affect the tube.

After the settings for the pressure range have been made, the governor will automatically maintain pressure within those limits.

The operation of the pressure governor is as follows:

Assuming that the pressure is at the low value, as indicated by the left hand indicator I, contact C on needle N completes the circuit through contact C′ on movable arm M, which at the low pressure point rests against the stop P′. When this contact is made, the circuit is completed through relay coil R, causing armature A to close. Attached to this is the contact CO, which, upon closing, completes the control circuit to the self-starter, causing the motor to start.

The armature is also attached to spring S, which holds contact C′ firmly against C until contact is broken at P.

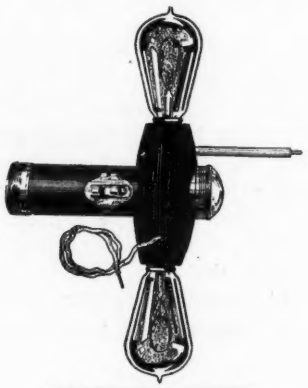
As the pressure increases, the needle pointer moves to the right, but its lower part to which contact C is attached moves to the left, and is followed by movable arm M. When the high-pressure point is reached, the movable arm is prevented from traveling further by stop P and the needle continues its course, breaking the circuit by separating contacts C and C′. The instant the circuit is broken, relay R is de-energized, its armature falls, releasing the tension of the spring S, and because the movable arm M is counterweighted it returns to stop post P′.

When the pressure is decreased to the minimum value, contact C again completes the relay coil circuit by engaging contact C′ and the cycle of operation is repeated.

The case is tapped and drilled at the bottom for the pressure pipe and electrical conduit connections.

Blake Illuminated Fuse Tester

UNLESS some form of tester (usually crude and home-made), is available, it is at present common practice to replace with new fuses all the fuses of a cut-out box in which one fuse has blown, waiting for a future opportunity to make a test to detect the blown fuse or fuses, and to replace in stock the fuses which have not operated. Not only does this method



BLAKE FUSE TESTER

unnecessarily consume time, but it requires a stock of fuses greater than that which answers the purpose where tests for operative fuses are made at the cut-out boxes.

An appliance designed to do away with waste of time and money to discover a blown fuse is announced, and is being marketed by R. S. Blake, 230 S. LaSalle St., Chicago, Ill.

Essentially, it consists of a device to test fuses in position with safety, while the back of fuse is illuminated by the light from a dry cell flash lamp. The tester is held in one hand, the light flashed on, and the necessary contacts are made by means of the two contact points shown in the illustration, one a stiff, heavy rubber-insulated wire, and the other a rubber-insulated flexible wire. The result of the test is immediately apparent by the lighting or remaining dark of the two test lamps arranged in series.

At present, the electrician who has equipped himself with a couple of sockets in series for testing fuses, needs a helper to hold the light, where the cut-out is in a dark spot, as is so often the case in many industrial plants, theaters, hotels, or on board ship, in mines, etc. With the above described combination of tester lamp and flash lamp, it is entirely possible for even a one-armed man to make the proper tests.

The sockets in the Blake Fuse Tester are standard Edison base sockets, and any standard lamp may be used in them. Any voltage up to 500 may be tested. In making tests on 500 volts, it is necessary to use two 220-volt lamps. In making tests 110-220 volt circuits two 110-volt lamps are used.

The device is practically indestructible, and is marketed with or without the flash light; thus if the electrician is provided with his own lamp, only the tester proper need be purchased.

THE E. M. DART MFG. CO. has recently moved into its new building at Thurbers Ave., Eddy and Blundell Sts., where it is better equipped to handle its rapidly increasing business. Mail should be addressed to the office at 134 Thurbers Ave., Providence, R. I.

ANNOUNCEMENT is made by the Ordnance Department of the establishment of a new district to be known as the St. Louis Ordnance District, with headquarters in that city. M. E. Singleton has been named as Ordnance Chief.

The territory covered by the new district will include the States of Missouri, Arkansas, Oklahoma, Texas, Kansas, Nebraska, Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Idaho, Washington, Oregon, Nevada and California. The district also includes all that portion of the State of Illinois lying south of the northerly boundaries of the following counties: Adams, Schuyler, Cass, Macoupin, Christian, Shelby, Cumberland and Crawford.

George J. Roberts, of East Orange, N. J., vice-president and general manager of the Public Service Corporation of New Jersey, was recently appointed as Ordnance District Chief of the New York District, and will have his office in the Albemarle Building, Broadway at 24th St.

The assignment of the St. Louis office to the Western territory completes the list of eleven districts into which this country has been divided, the complete list of cities in which offices are located now being: Boston, Mass.; Bridgeport, Conn.; New York, N. Y.; Chicago, Ill.; Cincinnati, Ohio; Cleveland, Ohio; Detroit, Mich.; Philadelphia, Pa.; Pittsburgh, Pa.; Rochester, N. Y., and St. Louis, Mo.

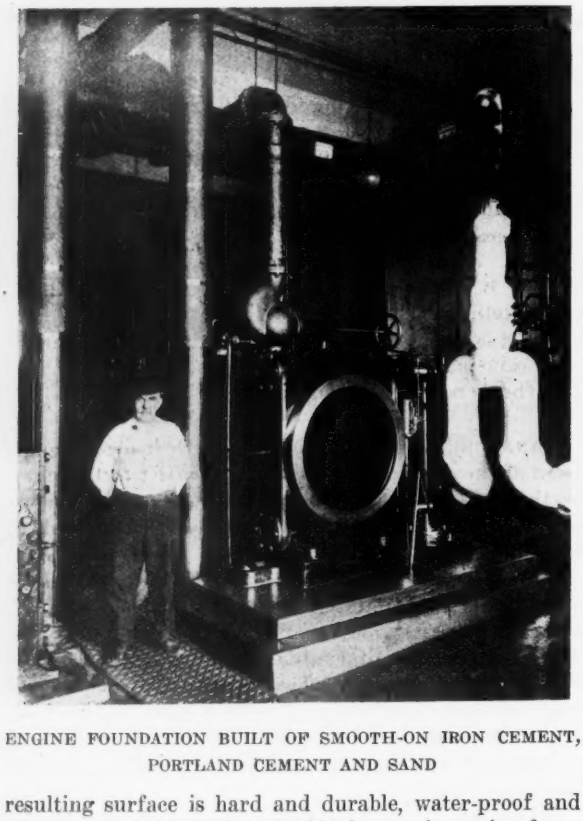
There is also an Ordnance District Office established in Toronto for handling business in Canada.

Building a Firm Engine Foundation

THE accompanying photograph shows the foundation of a 300-ton ice machine at Grauer's Ridgewood Park Brewery, Brooklyn, N. Y., which was constructed under the supervision of Peter Muller, chief engineer.

Mr. Muller had great difficulty with this foundation for over three years before he finally overcame it. The solution was very simple and is one which has worked with marked success in other similar cases. It consisted in mixing Smooth-On Iron Cement No. 7 with the Portland cement and sand.

The Smooth-On Iron Cement metallizes and expands as the concrete sets and forms a perfect bond. The



ENGINE FOUNDATION BUILT OF SMOOTH-ON IRON CEMENT, PORTLAND CEMENT AND SAND

resulting surface is hard and durable, water-proof and oil-proof, a particularly valuable feature in engine foundations, as the oil penetrates and weakens ordinary concrete and subsequent vibration causes it to disintegrate.

The usual mixture for such cases is: Smooth-On Iron Cement No. 7, 25 parts by weight; Portland cement, 100 parts; sand, 150 parts; grits, 50 parts.

Book Reviews

HEATING AND VENTILATING, by John R. Allen and J. H. Walker; cloth, 6 by 9 in., 300 pages, 172 illustrations, tables and charts; New York, 1918.

Both men who have collaborated in the writing of this book are authorities on the subject with long experience in the work and in presenting their ideas to others. They have covered the subject fully, from hot air furnaces for houses to central steam heating plants, but have condensed their statements into a volume easily read and consulted. The scope is best shown by the chapter headings as follows:

I, Heat and Its Measurement. II, Heat Losses from Buildings. III, Different Methods of Heating. IV, Properties of Steam. V, Radiators. VI, Steam Boilers. VII, Steam Heating Systems. VIII, Pipe, Fittings, Valves and Accessories. IX, Steam Piping. X, Hot-Water Systems. XI, Automatic Temperature Control. XII, Air and Its Properties. XIII, Ventilation. XIV, Hot Air Furnaces. XV, Design of Fan Systems. XVI, Air Washers and Air Conditioning. XVII, Fan Systems for Various Types of Buildings. XVIII, Central Heating.

Primarily this is intended as a text book on the subject, and includes, therefore, details in regard to piping, valves, fittings and installation, as well as scientific rules for proportioning heating surface, supply pipe sizes and arrangement.

Little mathematics is used, and where formulas are derived, they are reduced to simple forms which can be used, without studying the derivation, to get practical results.

Problems are given for the reader to work out, which will serve to fix the methods explained in mind, and to give practice in use of the formulas; but answers have been omitted, which is usual for class room work, but leaves the general reader in doubt as to the correctness of his solutions.

Important points are the calling of attention to correct proportioning of hot water systems to maintain an equable desired temperature, and the emphasis on temperature control and proper humidifying of the air to secure economical operation.

The book is up-to-date in methods advocated, well arranged, well written and informing.

MECHANICAL LABORATORY METHODS, by Julian C. Smallwood; Second Edition; New York, 1918; 400 pages, 5 by 7¼ in.; 114 illustrations. Price, $3.

As the title of the book would indicate, this is intended especially for the student who is permitted the use of a mechanical engineering laboratory; but as the man in the practical field uses similar instruments, though the methods of testing vary somewhat, the information given in the book is of value to anybody having testing of mechanical appliances to do. In the introduction the principles of experimental measurements are discussed under the topics: Classes of Errors; Limitations of Instruments; Standards; Measurements of Compound and Variable Quantities; Combining Discordant Observations; Rules for Testing. Following the introduction, Part 1 deals with the Testing of Instruments and explains how adjustments can be made, instruments calibrated and correction factors used. Part 2 deals with the Analysis of Combustion, Part 3 the Testing of Power Plant Units, and in the Appendix are given tables useful to the man working up test data.

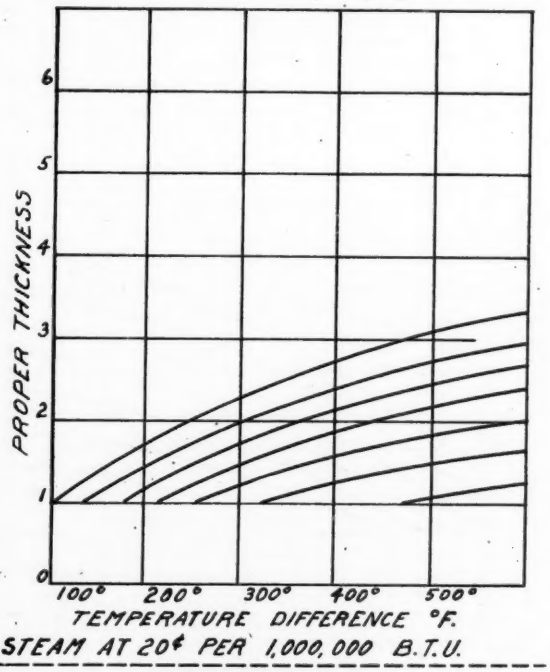
These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

POWER PLANT ENGINEERING

THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

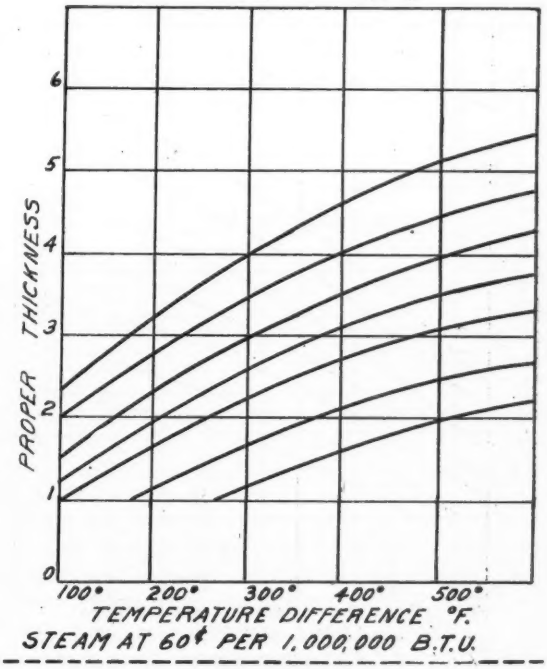
For Use in Plants Where Heat Costs, Steam Temperatures, Etc., Are Accurately Known, Based on Continuous Use of Piping



POWER PLANT ENGINEERING

THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

For Use in Plants Where Heat Costs, Steam Temperatures, Etc., Are Accurately Known, Based on Continuous Use of Piping



POWER PLANT ENGINEERING

THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

For Use in Plants Where Costs Are Not Accurately Known. Based on Continuous Use of Piping

COAL AT $2.00 PER TON					
Size Pipe In.	Hot Water 175 deg. F. In.	Steam 5 Lb. In.	Steam 100–200 Lb. In.	200 Lb. 150 deg. F. Superheat In.	200 Lb. 500 deg. F. Superheat In.
3/4	7/8	7/8	7/8	7/8	7/8
1-1/2	7/8	7/8	7/8	7/8	2
3	1-1/32	1-1/32	1-1/32	1-1/2	2
6	1-1/8	1-1/8	1-1/2	2	2
12	1-1/2	1-1/2	2	2	3
24	1-1/2	1-1/2	2	3	3
Flat	7/8	1-1/2	2	3	3-1/2

COAL AT $4.00 PER TON					
Size Pipe In.	Hot Water 175 deg. F. In.	Steam 5 Lb. In.	Steam 100–200 Lb. In.	200 Lb. 150 deg. F. Superheat In.	200 Lb. 500 deg. F. Superheat In.
3/4	7/8	7/8	7/8	1-1/2	2
1-1/2	7/8	7/8	1-1/2	2	2
3	1-1/32	1-1/32	2	2	3
6	1-1/8	1-1/8	2	3	3
12	1-1/2	1-1/2	3	3	4
24	1-1/2	1-1/2	3	4	4
Flat	2	2	3	4	4-1/2

POWER PLANT ENGINEERING

MATERIAL FOR 1 CU. YD. CONCRETE BASED ON A BBL. OF CEMENT CONTAINING 3.8 CU. FT.

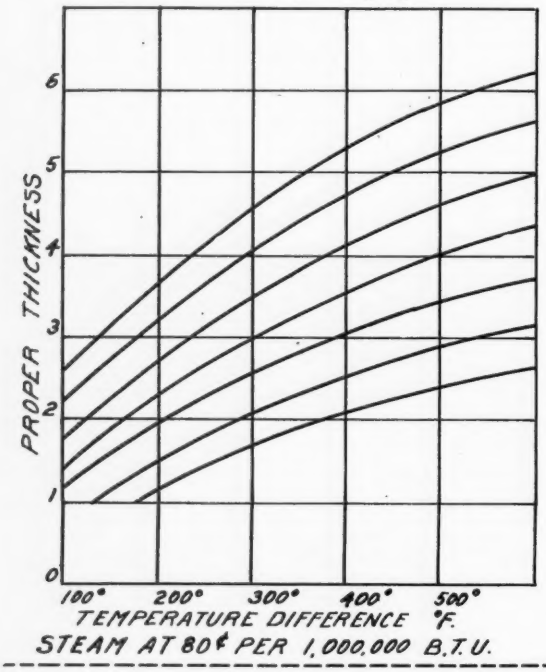
Revised by the editors from tables by Taylor and Thompson.

DATA

Proportions by Parts	Proportions by Volume	Cement Bbl.	Sand Cu. Ft.	Stone Cu. Ft.	Packed Cement Bbl.	Loose Sand Cu. Ft.	Loose Stone Cu. Ft.	Mortar % Vol. of Stone	Percentage of Voids in Broken Stone or Gravel: 50% Cement Bbl.	50% Sand Cu. Yd.	50% Stone Cu. Yd.	45% Cement Bbl.	45% Sand Cu. Yd.	45% Stone Cu. Yd.	40% Cement Bbl.	40% Sand Cu. Yd.	40% Stone Cu. Yd.	30% Cement Bbl.	30% Sand Cu. Yd.	30% Stone Cu. Yd.	20% Cement Bbl.	20% Sand Cu. Yd.	20% Stone Cu. Yd.
1	1	1	2	4	1	5.7	11.4	64	2.09	0.44	0.88	2.00	0.43	0.86	1.91	0.40	0.81	1.76	0.37	0.74	1.63	0.34	0.69
1	1½	1	3	6	1	7.6	15.2	57	1.63	0.46	0.93	1.57	0.44	0.89	1.51	0.42	0.85	1.38	0.39	0.78	1.27	0.36	0.72
1	2	1	4	8	1	9.5	19.0	47	1.47	0.41	1.03	1.39	0.39	0.98	1.32	0.37	0.92	1.20	0.34	0.84	1.10	0.31	0.77
1	2½	1	5	10	1	11.4	22.8	46	1.24	0.44	1.05	1.17	0.41	0.99	1.11	0.39	0.94	1.01	0.35	0.84	0.93	0.32	0.78
1	3	1	6	12	1	15.2	30.4	49	0.90	0.51	1.01	0.85	0.48	0.96	0.81	0.46	0.91	0.74	0.42	0.83	0.68	0.38	0.73
1	3½	1	7	14	1	15.2	34.2	44	0.84	0.47	1.06	0.80	0.45	1.01	0.76	0.43	0.96	0.70	0.39	0.78	0.64	0.36	0.69
1	4	1	8	16	1	15.2	38.0	40	0.79	0.44	1.11	0.75	0.42	1.06	0.71	0.40	1.00	0.66	0.37	0.73	0.60	0.33	0.65
1	5	1	10	20	1	19.0	38.0	47	0.73	0.52	1.03	0.69	0.49	0.97	0.66	0.46	0.93	0.60	0.42	0.84	0.55	0.38	0.74
1	6	1	12	24	1	22.8	45.5	46	0.62	0.52	1.04	0.58	0.49	0.98	0.56	0.47	0.94	0.50	0.42	0.84	0.46	0.39	0.78

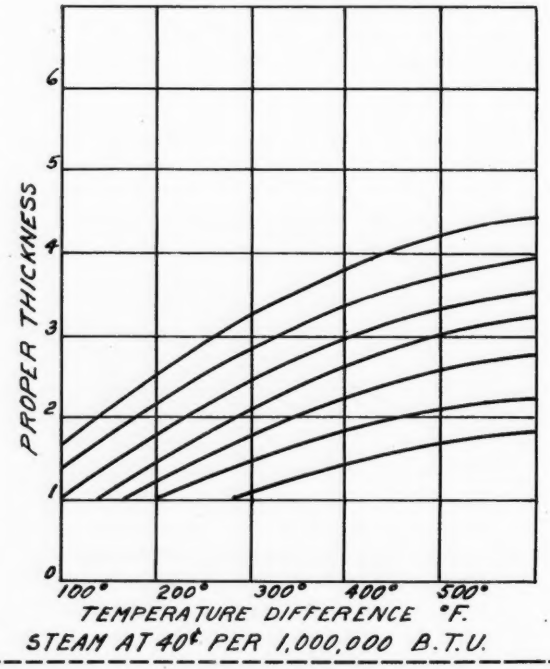
THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

For Use in Plants Where Heat Costs, Steam Temperatures, Etc., Are Accurately Known, Based on Continuous Use of Piping

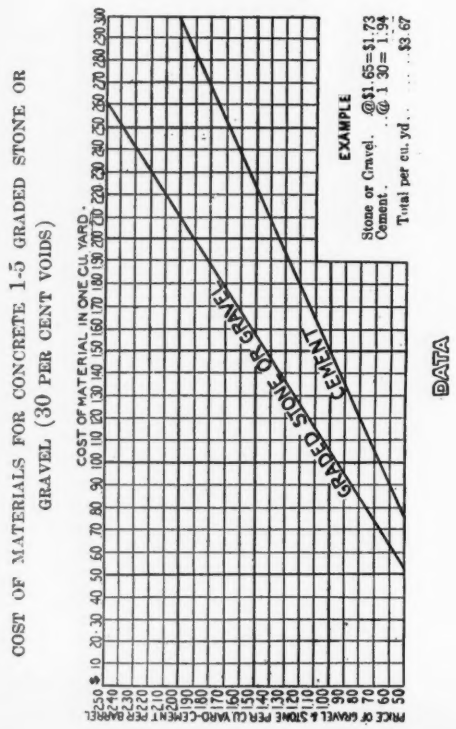


THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

For Use in Plants Where Heat Costs, Steam Temperatures, Etc., Are Accurately Known, Based on Continuous Use of Piping



COST OF MATERIALS FOR CONCRETE 1-5 GRADED STONE OR GRAVEL (30 PER CENT VOIDS)


COST OF MATERIAL IN ONE CU. YARD.
PRICE OF GRAVEL & STONE PER CU. YARD-CEMENT PER BARREL
GRADED STONE OR GRAVEL
CEMENT
EXAMPLE
Stone or Gravel. @$1.65=$1.73
Cement. @ 1.30= 1.94
Total per cu. yd. $3.67
DATA

THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

For Use in Plants Where Costs Are Not Accurately Known. Based on Continuous Use of Piping

COAL AT $6.00 PER TON					
Size Pipe In.	Hot Water 175 deg. F. In.	Steam 5 Lb. In.	Steam 100-200 Lb. In.	200 Lb. 150 deg. F. Superheat In.	200 Lb. 300 deg. F. Superheat In.
3/4	7/8	7/8	1-1/2	2	2
1-1/2	7/8	7/8	1-1/2	2	3
3	1-1/32	1-1/2	2	3	3
6	1-1/8	2	2	3	4
12	1-1/2	2	3	4	4
24	2	3	3	4	5
Flat	2-1/2	3	4	5	5-1/2

COAL AT $8.00 PER TON					
Size Pipe In.	Hot Water 175 deg. F. In.	Steam 5 Lb. In.	Steam 100-200 Lb. In.	200 Lb. 150 deg. F. Superheat In.	200 Lb. 300 deg. F. Superheat In.
3/4	7/8	1-1/2	1-1/2	2	3
1-1/2	7/8	1-1/2	2	3	3
3	1-1/2	2	3	3	4
6	1-1/2	2	3	4	4
12	2	3	3	4	5
24	2	3	4	5	6
Flat	2-1/2	3-1/2	4-1/2	5-1/2	6-1/2

POWDERED COAL AS FUEL, by C. F. Herington; 211 pages, 6 by 9 in.; 84 illustrations; New York, 1918. Price, $3.

Much of the information presented in this book was gained first hand by the author during his connection with the New York Central Railroad Co. and represents the results of pioneer work with this comparatively new form of fuel. The book, however, is as complete as present-day practice would permit, for it contains descriptions of all the important machinery used, principal installations in various industries and results of tests made of powdered coal burning furnaces. Those wishing information upon this subject will find this book valuable reading, as would be indicated by the following chapter headings: Introduction, general operation of plant, comparison of costs with oil and gas; Coals Suitable for Powdering; Preparation of Powdered Coal; Feeding and Burning Powdered Coal; Powdered Coal in the Cement Industry; Application of Powdered Coal to Reverberatory Furnaces; Powdered Coal in Metallurgical Furnaces; Powdered Coal Under Boilers; Powdered Coal for Locomotives; Explosions.

THE CHEMICAL ANALYSIS OF IRON, by Andrew Alexander Blair; Eighth Edition; Philadelphia, 1918; 318 pages, 6 by 9 in.; illustrated. Price, $5.

Intended to be a guide to the student of iron chemistry only, this book presupposes that the reader has some knowledge of general and analytical chemistry and some practical experience in laboratory work and manipulation. It contains a complete account of the best known methods for the analysis of iron, steel, pig-iron, alloy metals, iron ore, limestone, slag, clay, sand, coal and coke.

AT THIS TIME, when fuel engineers and manufacturers are deeply interested in the conservation of fuel in order that those industries essential to winning the war may not be handicapped, they will welcome a publication just issued by the Bureau of Mines of the Department of the Interior, giving thousands of analyses of coals from many hundred mines in the United States, for these analyses enable the users of coal to realize the amount of heat they are buying.

Bulletin 123, "Analyses of Mine and Car Samples of Coal Collected in the Fiscal Years 1913 to 1916," is a continuation of the sampling and analyzing of the coals of the country began by the Federal Government in 1904. It is the third of the series, Bulletin 22, "Analyses of Coals in the United States," which can now only be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 85 cents, being the first. The second bulletin of the series, Bulletin 85, "Analyses of Mine and Car Samples of Coal collected in the Fiscal Years 1911 to 1913," is still available for distribution by the Bureau of Mines.

The present bulletin presents analyses and descriptions of samples collected during the fiscal years 1913 to 1916. In order that the material in this bulletin may be used to supplement that presented in Bulletins 22 and 85, the same plan of geographical classification has been followed, the analyses and descriptions of the samples being grouped in alphabetical order according to the state, county and town near which the mines or prospects sampled are situated.

The three bulletins, which do not conflict, constitute a very extensive analyses of the coals of the United States and should prove of great value to those who purchase large quantities of coal. The day has passed when the industries buy coal as coal. They now buy heat units and know what they are buying. Bulletin 123 is of no particular interest to the domestic consumer of coal. It is for the industries that require large quantities of coal and to whom the cost of coal now is an increasingly large factor in the conduct of their works.

Copies of Bulletin 123 may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C., as long as the present edition remains.

Catalog Notes

NATIONAL STRESS emphasizes more than ever before the necessity of conserving coal. It must not be wasted. You would not think of deliberately throwing away shovelfuls of coal, but that is what really happens when heating surfaces are so fouled that a large portion of the heat goes up the stack.

Boiler scale is a poor conductor of heat and prevents a free interchange of heat, just as do the pipe coverings on your steam lines. Its presence can oftentimes cause a fuel waste of 20 per cent or more.

The principle of action of graphite in freeing a boiler from scale and keeping it free, and other interesting data, are contained in a booklet, No. 96T, which can be had by writing to Joseph Dixon Crucible Co., Jersey City, N. J.

THE GENERAL ELECTRIC CO. has issued Bulletin No. 44,017 on Miniature Direct-Current Instruments, Types DM and DK-7. These miniature direct-current instruments are of the D'Arsonval, permanent magnet, moving coil construction, and are excellent examples of fine design and high grade instrument work applied to very small parts.

Notwithstanding their small size, they are remarkably accurate and are designed especially for small panels, battery-charging sets, automobile starting and lighting sets, electric vehicles and general equipment for small direct-current installations.

CATALOG 1-B, wiring devices and carbon circuit breakers, is now being distributed by the Westinghouse Electric & Mfg. Co. This is a 224-page catalog listing fuses, knife switches, service switches and boxes, solderless connectors, disconnecting switches, instrument switches, safety switches, safety panel boards, safety floor boxes, and carbon circuit-breakers, part of which have previously been listed in the old sectional 3001 catalog of the Westinghouse Co.

An entirely new and complete line of knife switches of the Westinghouse Co.'s own manufacture, both front and rear-connected, types A and C, occupy 49 pages of this catalog. A new line of disconnecting switches, known as types P and R, are listed in this catalog for the first time.

In listing the carbon circuit-breakers, the company has made a departure from its previous practice. The carbon circuit-breakers are listed in this catalog accord-

ing to what they will accomplish, that is, according to the method of operation, method of mounting, and their capacity, the type designation being the secondary consideration in the table of listings. On looking up the circuit-breaker to accomplish a particular duty, all that is necessary is to find from the cleverly prepared index in the beginning of the tables, the particular table listing the breakers according to the operation and method of mounting desired, and then, in that table, follow down the list until the number of poles, the ampere and the voltage capacity is found. A type designation is shown with this so that those wishing to know the details of construction of the breaker that will give their required operating characteristics can easily find them on the pages of description.

SCIENTIFIC INDUSTRIAL ILLUMINATION is the title of a 36-page illustrated booklet recently issued by the Holophane Glass Co., 340 Madison Ave., New York City. This booklet is divided into four parts. The first part shows the need for scientific illumination and discusses its economic advantage. The second section discusses the fundamental principles of scientific illumination. The third part describes and illustrates new types of industrial lighting units manufactured by the company for shop, factory, office and drafting room illumination and for yard and protective lighting. The fourth section contains a collection of general engineering data which should make this book especially valuable as a ready reference book.

A CHAIN OF EVIDENCE, is the title of Publication No. 15, Small Power Drives, from Morse Chain Co., Ithaca, N. Y. This pamphlet includes drives up to 100 hp., enumerating advantages of Morse Silent Chain Drives for transmitting small powers, and showing by many halftone views, examples of their uses.

DEANE OF HOLYOKE vertical triplex power pumps, single and double acting, are illustrated and described in Bulletin D-702 just issued by Worthington Pump & Machinery Corporation, 115 Broadway, New York.

BULLETINS have been received from Tate-Jones & Co., Inc., Pittsburgh, Pa., as follows: Bulletin No. 156, on pumping systems for oil burning installations; No. 157, on fuel oil burners for boilers; No. 158, on fuel oil burners for furnaces.

CLARAGE FAN CO.'S Catalog No. 22 contains data, illustrations, and capacity and dimension tables of the company's pressure blowers. A copy of this catalog may be had by addressing the manufacturer at Kalamazoo, Mich.

FOLDERS have been received from the Ross Heater & Mfg. Co., of Buffalo, N. Y., illustrating and describing the crosshead-guided expansion joint, surface condensers and multi-head water heaters manufactured by that concern.

THE LEVIN oxygen and hydrogen generator is described in Bulletin G, recently received from Electrolytic Oxy-Hydrogen Laboratories, 15 William St., New York.

A FOLDER from American Can Co., 1230 Monroe Bldg., Chicago, illustrates the American split keyboard statement machine.

AMERICAN STANDARD cast-iron flanged fittings for standard and extra heavy pressures are tabulated in a 22-page book from Lynchburg Foundry Co., Lynchburg, Va.

CALOREX liquid fuel furnaces and equipment, apparatus for burning oil or tar in combination with coal or bagasse, are the subject of Catalog No. 28 from W. N. Best, Inc., 11 Broadway, New York.

FUEL WASTE IN THE POWER PLANT is the title of a booklet being distributed by the H. W. Johns-Manville Co., giving helpful suggestions for preventing losses in the boiler room, in the engine room, radiation from steam pipes and outdoor distribution lines.

THE ENGINEERING DEPARTMENT of the National Lamp Works has recently published Bulletin 34, which deals with country home lighting. A general discussion is given of the generating plant and wiring. Stress is laid upon the fact that satisfactory operation depends to a great extent upon the installation of wire sufficiently large to carry the necessary power without an undesirable voltage drop. A table is given which will facilitate the selection of wire of the proper size.

Photographs of actual installations are used to illustrate the lighting of the home. While the discussion of the lighting of the house is thorough, it is not involved with mathematical calculations for which the average owner of a home lighting plant would have small use. A section has been devoted to lighting the horse barn, hog house, garage, silo, etc. A short descriptive section is given to Mazda lamps for country home lighting service.

Copies of this bulletin may be obtained, upon request, from the Engineering Department, National Lamp Works, Cleveland, Ohio.

AMONG THE NEW BOOKLETS published is "Dixon's Graphite Brushes," that is well worth keeping for reference.

This booklet tells the story of how graphite brushes came into being and describes the advantages of graphite brushes. The various conditions of service are also described and recommendations made as to where graphite brushes may be used to the best advantage.

The two center pages are devoted to an arrangement of prices and sizes so that the cost of any size brush may be found in a minute; also rules as to how to order graphite brushes.

Other graphite electrical specialties, such as resistance rods and lubricating rods, are shown and described.

Graphite brushes will not cut or scratch the commutator. They prevent sparking and wear of the commutator and have a long life if properly adjusted. A copy of this booklet will be sent to anyone interested. In writing, please be sure to tell us the number of brushes used on the machine, the dimensions of the brushes, the number of amperes at heaviest load, and the class of service in which the machine is operated. Address Department 96-M., Joseph Dixon Crucible Co., Jersey City, N. J.